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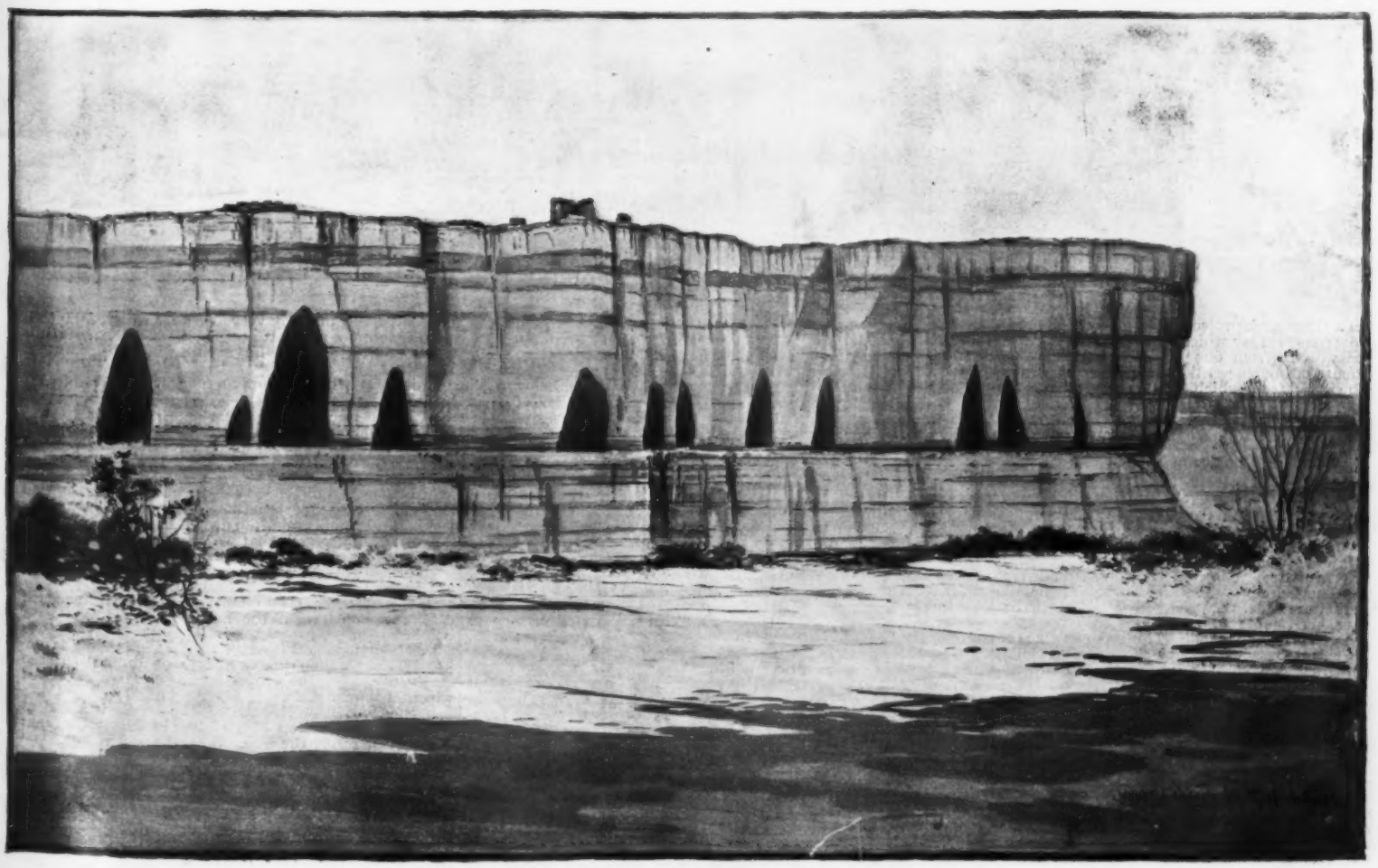
ABORIGINAL REMAINS IN VERDE VALLEY, ARIZ.*

By COSMOS MINDELEFF.

THE remains in the valley of Rio Verde, southeastern Arizona, are near the southwestern limit of the ancient Pueblo region. Here are remains of large villages with elaborate and complex ground plan, indicating a long period of occupancy, and ruins of small villages with simple ground plan; also an exceptional development of cavate lodges and almost entire absence of cliff dwellings. The domiciliary ruins of the region visited by the writer fall into the following classes: Stone villages, cavate lodges, bowlder marked sites and irrigating ditches and works. The stone villages on bottom lands represent in size and in degree of skill attained by the builders the highest type in the region. The ruins of villages on defensive sites are also found throughout the whole region, one very small village occupying the whole summit of a large rock which projects into the stream, and is connected with the mainland by a natural causeway or dike.

Cavate lodges are distributed generally, and are found at many points where there are outcrops of a calcareous sandstone, very soft and strongly laminated, and therefore easily excavated, the formation often appearing in the cliffs and small canyons bordering on the streams. In some cases stone villages occur in conjunction with and subordinate to the cavate lodges, while in other cases the order of this interdependence seems to be reversed. Bowlder marked sites are thickly scattered over the whole region, and are supposed to mark the sites of small farming or temporary shelters. They often occur in connection with irrigating ditches and other horticultural works. Fine examples of irrigating ditches were found in the northern and southern

RUINS ON EMINENCE FOURTEEN MILES NORTH OF FOSSIL CREEK.



OPEN-FRONT CAVATE LODGES ON THE RIO SAN JUAN.

*Abstracts from an elaborate paper in the Thirteenth Annual Report of the Bureau of Ethnology to the secretary of the Smithsonian Institution, by J. W. Powell, director.

portions of the region. The largest ruin on the Verde covers an area of over five acres and has some 225 rooms on the ground plan. It is about a mile above the mouth of Limestone Creek, and its plan is similar to that of Zuni, the largest inhabited pueblo at present. One of our illustrations represents a ruin about fourteen miles north of Fossil Creek, on the eastern side of the Verde. A large rock rises at the intersection of two washes, about a mile back from the river, and on a bench near the summit are the remains of walls. There seem to have been only a few rooms on the top of the rock, and the debris on the ground at the base of the rock on the side shown in the illustration is rather scanty, although there is more on the opposite side. This ruin commands an extensive outlook over a large valley below and two small valleys above.

Cavate lodges are structures not widely known, and are closely related to cliff houses and cave dwellings. These occur in considerable numbers, near the mouth of the San Juan River, on the Rio Grande near Santa Clara, near Flagstaff, Arizona, and in the middle Verde region. Several groups of cavate lodges were described by W. H. Holmes, of the Hayden survey, and among these were the open-front lodges on the Rio San Juan, shown in our illustration, of which Mr. Holmes wrote:

"I observed, in approaching from above, that a ruined tower stood near the brink of the cliff, at a point where it curves outward toward the river, and in studying it with my glass detected a number of cave-like openings in the cliff face, which I found to have been shaped by the hand of man, but so weathered out and changed by the slow process of atmospheric erosion that the evidences of art were almost obliterated. The work of excavation has not been very great, with the imperfect implements that must have been used, as the shale is soft and friable. A hard stratum served as a floor, and, projecting in many places, made a narrow platform by which the inhabitants were able to pass along from one house to another. Small fragments of mortar still adhered to the firmer parts of the walls, from which it is inferred that they were at one time plastered."

In another illustration is represented a small section of a cliff containing lodges which seem to have been quite elaborate in their internal arrangements, having main front room and attached back rooms. The cavate lodges of the Rio Grande have been assigned to the Santa Clara Pueblo Indians, and there is a tradition that they have been occupied during three successive periods, the last occurring after the Spanish conquest of New Mexico in the seventeenth century. Major Powell says:

"Above the cliffs, on the mesas, evidences of more ancient ruins were found. There were pueblos built of cut stone rudely dressed. Every mesa has at least one ancient pueblo upon it, evidently far more ancient than the cavate dwellings found in the face of the cliffs. It is then very plain that the cavate dwellings are not of great age, that they have been occupied since the advent of the white man, and that on the summit of the cliffs there are ruins of more ancient pueblos."

In 1895 10,549 applications for patents were filed in France, and 8,848 patents were issued, while sixteen applications were rejected and two hundred and seventy-eight withdrawn. The greatest number of patents, 953, was in the class of carriages and velocipedes, and the next largest, 295, in chemical products. The smallest number, 74, was in powders and explosives. A very large proportion of the whole number, viz., 8,709, were taken for the longest term of fifteen years.—La Propriété Industrielle.

WHALE FISHING.

Whales are not yet upon the point of disappearing from the surface of the sea. In order to be convinced of this, it is only necessary to travel on the oceans that border upon the poles. In such regions they are met with every day, but, being often pursued, they have become more and more suspicious and more difficult to capture, and it has become necessary to completely modify the implements used in fishing for these large cetaceans.

Formerly a whale ship was, as a general thing, a large three masted vessel of from 500 to 800 tons, or sometimes more, which was very strongly built, with a view to withstanding the pressure of the ice, and was manned by a large crew. The vessel set out for a long cruise, which sometimes lasted one or two years. When whales were met with, the ship hove to, and, her boats having been lowered, the whale was pursued and attacked with the harpoon and lance, not without great danger to the assailants. After the animal had been captured, it was towed to the side of the ship and cut up in a peculiar manner, which consisted in removing the skin spirally, pretty much as one peels an apple. This skin was charged with blubber from eight to twelve inches in thickness, which was tried out on board of the vessel. The whalebone, which constituted the most valuable product of the animal, was carefully collected, and the gigantic cadaver was then left to rot. In this way a mass of flesh and bone, which possessed a certain value, was lost.

At present the fishing has become more of an industry. Although there still exist a few whaling vessels that proceed as above described, the majority of the whales captured are pursued by small vessels constructed especially for the purpose.

These vessels, which are regular pygmies as compared with the giant that they are designed to pursue, are scarcely more than sixty feet in length and gage from forty to eighty tons.

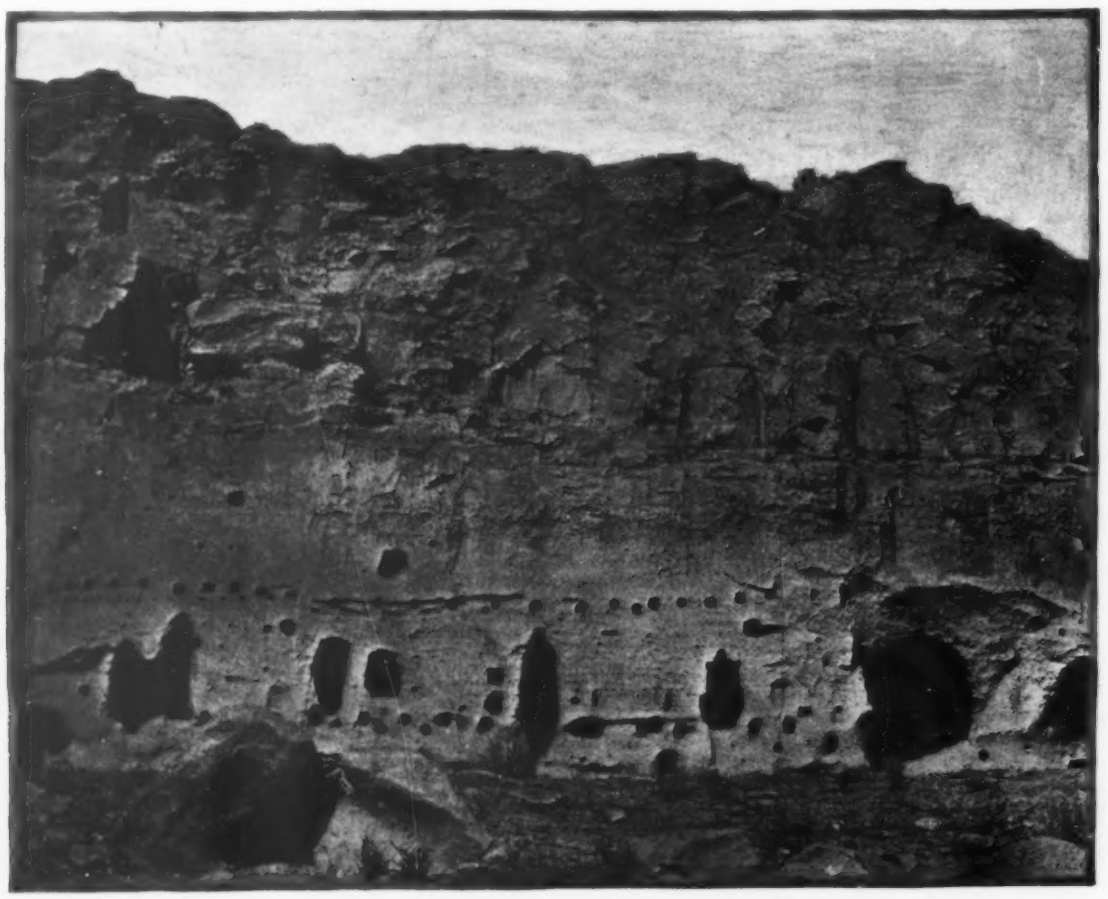
It may be imagined that these whalers, being of so small size, cannot undertake the long cruises of their predecessors, which were travelers, hunters, and carriers of a trying house and of manufactured products. Applying the modern principles of the division of labor, our whaling vessels have preserved only the role of hunters. The trying house is now on land, at the end of a well sheltered fiord, upon a bank having a gentle slope and near a river or torrent that furnishes it with motive power, or, at least, the water necessary for its boilers.

These trying houses are naturally installed in the neighborhood of the quarters frequented by the whale. There are several of them on the Lofoden Islands (northwest coast of Norway); there is one in the vicinity of Vardoe, a small town situated upon the coast of Lapland to the east of North Cape; and, finally, there are at present five in Iceland.

The one represented in our engraving may be taken as a type of all the rest. The boat figured here is not a whaler, but a towboat, the mission of which is to supply the fleet of whaling vessels with food and ammunition and bring in the captured whales. The latter, in our engraving, look like huge leather bottles in which the eye does not find the conventional form of the whale and is puzzled by the close pressed ribs that extend from one end to the other. This is due to the fact that the whale belongs to the variety called "wrinkled belly," and that, having been dead for some time, the gases due to decomposition, in distending the belly, have turned the cadaver upside down. So it is necessary to have a strong stomach to visit one of these trying houses, where there is a constant disengagement of odors of putrefaction, mingled with a smell of rancid frying that few stomachs can stand. The products obtained are the horny fringed plates known in commerce as whalebone, the price of which is increasing every year, and the oil, which is divided into two qualities. The first of these is obtained by trying out the blubber in a water bath, and the second by boiling the flesh. The latter is cut up by a sort of steam guillotine that has a very rapid motion. The flesh, freed from the oil that it contained, is dried in special ovens and then brayed and converted into a brown powder, which is nearly odorless and resembles tan, and which is sold as a fertilizer. Finally use is found for the bones, either in their natural state or in the form of animal charcoal.

At the Onondar Fiord works, which are the ones that we illustrate, as many as two hundred whales are treated every year. Each of these is, on an average, ninety feet in length, and yields products to the value of $750, say a total revenue of $150,000; but the expenses are heavy, since the plant is extensive and the employes are exacting as to the amount of their salaries. Nevertheless, the income from the capital invested remains as yet quite satisfactory.

Let us return to the whaling vessels which we left for a moment. These little vessels are provided with powerful engines, that give them a speed of from twelve to thirteen knots. At the bow is placed the cannon that fires the harpoon shell. This projectile, in fact, is designed to kill the whale while at the same time holding it captive. So the shell, in starting, carries along a hemp line of the first quality as thick as the wrist and yet as flexible as silk, and which costs in the neighborhood of $500. After the shell, the line continues in passing over a pulley suspended from the middle of the mast by very elastic springs, and then winds around a small steam winch placed back of the engine, and ends in a large tub, where it is washed with care.



CAVATE LODGES ON THE RIO GRANDE.

This little winch is simply a marvel of mechanics. It has to play the role, ten times centuplicated, of the reel of a trout line. While the whale is furiously struggling, the man who maneuvers the winch has to keep the line constantly taut through its intermedium, but neither too taut nor too loose. During the entire death struggle of the animal, which is often very lengthy, he is obliged to keep cool in order to wind and unwind his line ten times a minute. The fate of the boat depends upon him at this instant.

The whaling vessels that we speak of are all of Norwegian construction. The crews consist also of Norwegians. It is useless to say that they are men of exceptional energy and endurance.

In their expeditions a man is put at watch in a small cask suspended from the masthead. As soon as a whale is sighted, the vessel heads for it. In most cases the animal makes its escape, and then pursuit is useless. There is sometimes a chance of finding it asleep on the surface of the waves. It can then be approached within a short distance and be fired at.

If the shot is well directed, the whale is killed at once by the explosion of the shell in its vital organs; but such is rarely the case. Sometimes it seems to be stunned for a few moments, but in the majority of cases it plunges head foremost with fearful rapidity, and carries along the vessel, which it tows through the harpoon cable. In this critical moment a false movement of the tiller by the pilot or a false maneuver of the winch would capsize the vessel if the line were not cut in time.

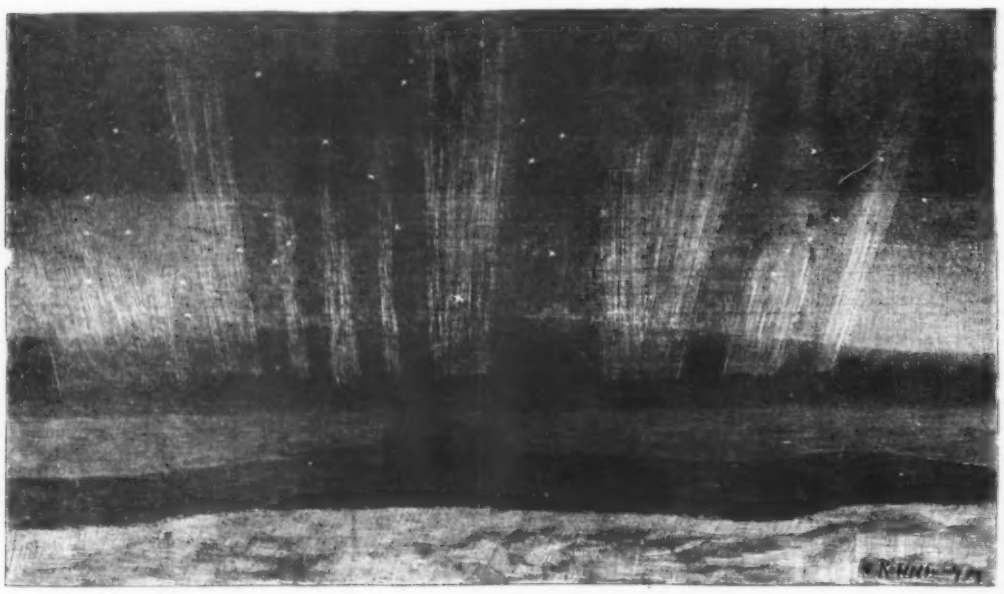
As soon as it is dead, the whale returns to the sur-

TOWING WHALES TO THE ONUNDAR FIORD TRYING HOUSE, ICELAND.

face. After it is rendered certain that there is nothing to be feared from its last convulsions, it is seized by two turns of a chain passed around it at the tail end and then passed through the hawse hole. The animal thus lies alongside of and parallel with the vessel, tail forward, and is carried to the nearest tow boat cruising in the vicinity, which takes it in the same manner in order to tow it to the trying house. This apparently abnormal process of towing the whale wrong end foremost is employed for two reasons. First, because of the tenuity of the base of the tail, which makes an excellent attaching point, and, second, the huge size of the mouth, which would open under the action of the current and offer a great resistance to towing.—L'Illustration.

NORTHERN LIGHTS AS SEEN FROM THE BROCKEN.

WE publish to-day an engraving (for which we are indebted to the Illustrirte Zeitung) showing the northern lights or aurora borealis as seen from the Brocken, a mountain in Prussia, on the night of January 2. It was the first remarkable display of this nature that had been seen in central Germany since March 30, 1894; and this was entirely shut off from the plain by heavy clouds and fog. Sometimes the currents of air which sweep the Brocken on all sides, especially those that come from the ocean, seem to deposit all of their vapors on the mountain in the form of clouds, and then again, when the valley is covered with fog or rain or snow is falling on it from the lowlying clouds, the Brocken stands out against a cloudless sky. The latter was the case on January 2; soon after dark every cloud above it had disappeared, while everything below was completely enveloped in clouds, and a bank of fog so thick that not a star could be seen through it extended up from the horizon for a distance of about 3°. At first masses of faint, straw-colored light without decided form or contour appeared in many places in the northern heavens; they entirely disappeared at times and did not take any definite shape until about half past seven; then an arc of light was seen, which extended from north-northeast to west-northwest, that is, in a horizontal direction, and culminated at a point where the arc attained a height of about 44½°. The lower part of this band of light was sharply defined, and was a faint straw color, while the upper part, in which a greenish gray color prevailed, faded gradually into the star lit sky. The arc of light seemed to end about 3° above the horizon, but really terminated in what is known as the dark segment, through which stars can ordinarily be seen. The ends of the arc of light and the segment were on this occasion, however, covered by a bank of mist until about ten o'clock, when the mist disappeared and the display became more brilliant and varied, attaining its greatest brilliancy about 10:30, at which time the sky appeared as shown in the engraving. After this the light became fainter, but at midnight it was brighter again and then vanished about 12:30. The spectacle began with the northern light haze and closed in the same way. At the time of its greatest development the display seemed to consist of a combination of the segment above referred to with streams of light diverging upward. On March 30, 1894, it was quite different; then, after the spectacle had been introduced with a blood-red haze, the streams of light took the form of ribbons and draperies which continued very brilliant until paled by the approaching dawn.



NORTHERN LIGHTS AS SEEN FROM THE BROCKEN, ON JANUARY 2.

DRAWN FROM NATURE BY AD. RETTELBUSCH.

THE VARYING POWER OF TORNADOES AND THEIR FREQUENCY.

PERHAPS the most important distinction to emphasize is that between the appearance of a thunder storm and a tornado, since, if this can be defined, much needless fear at the approach of black but harmless thunder storms can be avoided. When not combined with tornado manifestations, the thunder storm sends aloft a narrow line of black clouds in advance which remains high in the air. At the right and left the black clouds seem to reach the earth, but this is caused, not by a descent to the earth, as in a tornado, but by distant edges of the high black clouds receding below the horizon line. It is one storm, which spreads to the left and right. There is no splitting up of clouds with the formation of a different storm at another part of the horizon.

The tornado is easily distinguished from this perfectly plain edge of black with its lighter rain mist extending to the earth. Whether the funnel is veiled by rain or not, it is ordinarily so black that as it approaches it appears as a column of dense darkness, narrowest at the earth, with light breaking through on either side of it. The most marked trait of all is that other clouds seem to be approaching, others moving at right angles, and a distinct storm of light hue is coming up from the southwest. This is all caused by the tornado, which is drawing clouds and air currents toward itself from great distances. As the tornado funnel comes nearer, with its dark mass of rubbish reaching to the earth, the roar is frightful, giving the observer fifteen or twenty minutes' warning. The southwest corner of the cellar, if the tornado is approaching from the south or west, is the safest place of refuge. The tornado carries the wreckage to the north and east, and if the funnel is seen in the north or east it need not be feared, because it will almost certainly move away. Of six hundred tornadoes specially classified, all but thirty-five moved from southwest to northeast, and nearly all the thirty-five moved eastwardly.

The funnels have a rotary motion from right to left, and this motion is not due to electrical action, but to acceleration of conflicting air currents. Lieutenant Finley shows that the lightning supposed to be in the funnel is really in adjacent thunder clouds. The broken and withered buds, bruised by the action of the air, are evaporated by the sun after the tornado, causing the foliage to look seared, giving rise to the error that the tornado manifests burning electrical power. It has been demonstrated by study of wreckage that as the funnel leaves the earth and rises into the air its force slightly diminishes, and that this bounding motion causes the funnel to spare one building and demolish another. The funnel, with its small end to the earth, spins like a top, moving along at an average rate of about forty miles an hour, but the velocity of the spin is incalculable. It is like the motion of air impelled by an explosion.

Tornadoes generally occur between 3 P. M. and 5 P. M., and not more than one in a thousand takes place between 10 P. M. and noon of the following day. I have heard of only two instances in which the tornado occurred between midnight and morning—one at Hohokus, New Jersey, and another in Southern Michigan which caused slight loss of life. Since these are only two in about two thousand cases, the danger from tornadoes at night is so small that it need not be considered.—Harper's Weekly.

THE GOVERNMENT'S HOSPITAL FOR PLANTS.

THE government is just now establishing the first extensive experiment station in the world for carrying on plant vivisection. Every eater of vegetables and lover of flowers will be interested to learn of it, for it concerns them. It is a new institution, with a new purpose. Plant diseases must be understood and classified as definitely as animal ailments.

In this pest house the agricultural department's chief plant doctor will subject the hundreds of unflinching creatures of the vegetable world to the myriads of diseases which each year devour the farmer's crops and greenbacks. These subjects will endure their illnesses for the common good of their fellow plants. They will be to the vegetable doctor what the vivisection menagerie is to the student of animal diseases. They will teach farmers and growers books full of facts yet undreamed of, unless anti-vivisectionists prevent. In a few years Uncle Sam will be issuing plant doctor books to his husbandmen.

The new experiment station is being developed by Prof. B. T. Galloway, chief of the division of vegetable pathology. The professor recently took the writer through his unique workshop, which occupies a large glass house at the rear of the department building. Here have been arranged all sorts of paraphernalia for inoculating plants with disease germs and feeding them improper foods. A separate room is being equipped for the artificial manufacture of all kinds of climate and the study of its effects upon sickly as well as healthy plants.

During the writer's visit many valuable experiments were in progress. An important test was being made with "rust," the most destructive wheat disease, which makes the American farmer unhappy. Recently the agricultural department sent to all parts of the world where wheat is grown and collected 1,000 samples of different species. These are being planted with the hope of finding some variety which cannot fall sick when inoculated with the germs of "rust." Prof. Galloway regularly squirts these baneful microbes upon them and anxiously awaits each result. He works with the delicate baby sprouts only a few days old, grown by planting the wheat in raw cotton kept moistened with the diseased water. He is also cross-breeding some foreign wheats with those of this country.

Another interesting experiment had just been made with a violet plant. It was for testing the evil effects of bad ventilation. The plant was put under a glass bell jar, and no air was allowed to get in or out. The germs of a disease found to injure violets were mixed with water and sprayed upon the plant. Soon its leaves broke out in large yellow spots. It would not have caught the malady had not its system been first pulled down by ill ventilation. After the bell jar was removed the patient rapidly recovered.

Valuable results are also being obtained from feeding experiments. A row of young corn, standing in an irregular alignment of sizes, furnishes the subjects. These are given water of different quantities, and mixed with certain proportions of salts, as found in the natural soil. The roots are covered with hairlike tubes, the mouths through which the plants drink. When certain strengths of salt are added, these mouths become so badly puckered up that the plants starve to death. Plants which grow in salt marshes, along the seaside, are especially supplied with larger mouths. By learning how much salt was in his soil, the farmer can tell how healthy his corn crop will be. The same is being done with other plants, and the results, when published, will be of great value.

Tests are here being made with a newly conceived system of watering plants. The usual method is to throw the water on the surface, and let it soak through to the root. According to this new method, the moisture is applied underneath. A long trough is filled with plants. A pipe at either end, extending over the surface, connects underneath with a line of hollow, terra-cotta cylinders, very porous. These are placed end to end, not jointed. The water poured in at either extremity leaks through the cracks or through the pores.

Still more interesting experiments in changing the breeding powers of plants have begun. The most conspicuous results are obtained from Easter lilies. The inside of the lily is an inverted bell with six or more clappers. One looks like a long, white pin, with a flat, sticky head. The other clappers resemble miniature cat tails, very yellow at the end. When the bell shakes, a yellow powder, pollen, rubs off the cat-tails and sticks to the sticky pin head. The moistened pollen is taken into a cell in the funnel neck. Here the seed grows. Prof. Galloway finds that by cutting off all the pollen covered cat-tails and leaving only the pin-shaped red, the lily will grow stronger and more beautiful. The process corresponds exactly to another often applied to higher living things, and gives the same beneficial results.

Carnations are just now the fad, and much valuable work is being expended upon them. They are cross bred by taking the pollen of one kind and rubbing it on the pinlike rod of another. A great fault found with carnations is that they go to sleep at night. At such times they close and lose their beauty. This is especially so when worn by ladies in ball rooms and other places where many people are assembled. It is assumed that this is due to a preponderance of gases breathed out of the human lungs. To definitely investigate this malady carnations are being grown where carbonic acid and other gases may be fed to their leaves.

A separate room is being equipped as a laboratory for studying effects of climate and such environmental forces upon plants. Here is erected a large glass case, in which any kind of weather may be artificially manufactured, merely by the turning of levers or the opening of spigots. The case is divided into an upper and lower compartment by a wooden shelf. Gas heaters are placed in the lower division. These may be set so as to keep the air within exactly at any high temperature, neither above nor below it. Ammonia gas apparatus is ready, on the other hand, to bring the air down below zero at any time desired. An air pump attachment may be used to alter the barometric pressure or to force in gases of any kind. Here the different constituents of the air may be added in different proportions, to test effects of ventilation. Equally simple equipment will change this atmosphere from damp to dry or dry to damp. Thus plants may be grown here under the same conditions as at either the north pole or the equator, upon a high mountain or in a deep valley, in sunshine or in rain, in ill ventilated rooms or the purest air.

In this laboratory an interesting machine has been recently devised to measure the exact weight of water per second which the leaves of plants give out to the air. Plants perspire just as do men. The more they perspire the more must be taken in at the roots and the faster they grow. By keeping record of this circulation, you may feel a plant's pulse, so to speak. It is placed in a pot covered over with airtight rubber, leaving only the stem and leaves exposed. The whole is placed upon a carefully poised balance. As soon as the plant loses one-tenth of a gramme of water, by evaporation, the balance trembles, but by complicated machinery is made to recover its equilibrium immediately. The trembling, however, is enough to close an electric circuit and record the loss of one-tenth of a gramme upon the cylinder of a chronograph. Thus at the end of an hour, or any length of time, it may be learned exactly at what second each of these slight losses of weight was made, and by adding the little marks the aggregate loss of water is estimated.

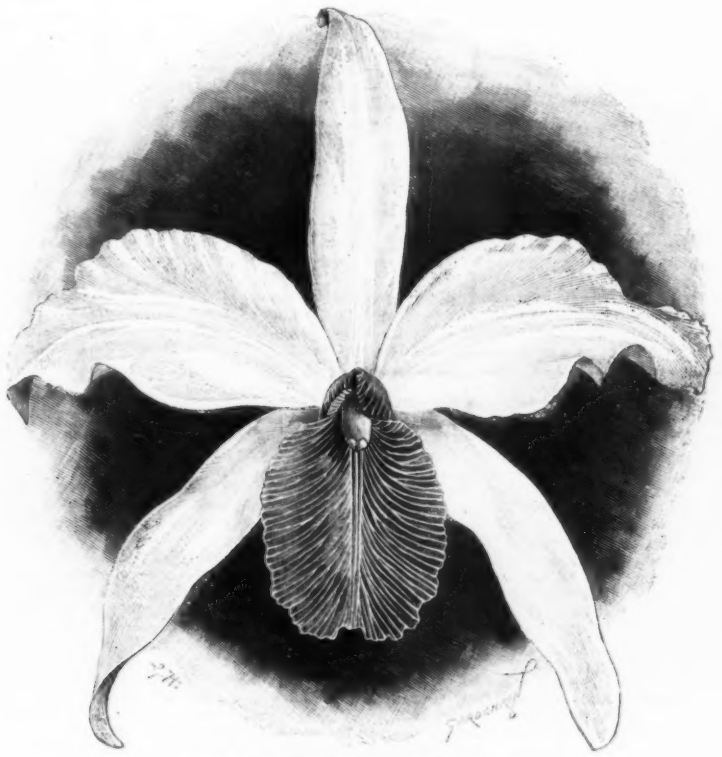
By studying vegetable cells more and more closely, scientists are learning how very slight is the difference between some of the higher plants and the lowest animals. Plants have many diseases corresponding to those of animals. In Florida orange trees suffer and often die of violent indigestion and dyspepsia caused

by indulgence in too much nitrogen from fertilizers. A very common complaint is plant measles, in which leaves break out in multitudes of small red spots. Chlorosis attacks plants as it does bloodless persons. It, in like manner, results from a lack of iron in the system. Hence the old folk lore advising the hanging of horseshoes or driving of nails in trees to make them healthy. Olive trees suffer from severe forms of tuberculosis. The bacilli is developed in their tissues, and the only cure is amputation of the diseased limb.

According to Prof. Galloway, he has heard many proposals that plant physicians, as well as animal physicians, should be educated for practice in large farms and gardens. There are great possibilities, in his opinion, that such specialists will some day find an encouraging patronage. In dealing with them, however, farmers and growers, he advises, should apply the rule of the Chinese. The Chinese doctor receives his salary as long as his patient is well, but loses it during the days he is ill.—Washington correspondent Boston Herald.

LÆLIO-CATTLEYA × DECIA ALBA.

AMONG the most beautiful and useful of the autumn and winter-flowering hybrid orchids are the various crosses made between species of Cattleyas and Lælio Perrini, and one of the brightest and richest in color was Lælio-Cattleya × Decia, which was shown on several occasions at the Royal Horticultural Society in 1895. But in 1896, out of the same batch, Messrs. Veitch & Sons flowered a single plant bearing clear white sepals and petals, and a most delicately tinted soft rose pink labellum beautifully veined with silvery white, and which was adjudged to be the best new hybrid orchid of the year, upon its being exhibited at the Royal Horticultural Society as Lælio-Cattleya × Decia alba, November 24, 1896, when it received a first-class certificate. We have much pleasure in giving an



LÆLIO-CATTLEYA × DECIA ALBA

Segments, white; lip, rose-pink, veined with silver.

illustration of this unique variety, which, being home-raised, is doubly interesting as pointing to the manner in which albinos are produced from seeds in a wild state.—Gardeners' Chronicle.

THE MAKING OF AN HERBARIUM.*

By CLEMENT B. LOWE.

A SERIES of practical suggestions are wanted as to the best method of collecting, identifying and preserving plants for making an herbarium.

In answering the above query, I would state that it is a pity that more pharmacists are not interested in field botany, as, aside from the valuable information thus to be obtained, the collection of plants is a healthful occupation, and tends to give the outdoor exercise which so many of them need.

In collecting plants, a suitable receptacle for containing them is necessary, which should be as nearly air-tight as possible, so that the contents can be kept fresh for several days. A japanned tin box, about 17 in. long by 7 in. wide and 4 in. deep, with a lid opening nearly the length of the flat side, suspended from the shoulder by a strap, will answer the purpose well.

Many prefer to take a stout portfolio, either hinged on one side or fastened on both sides by straps, containing numerous sheets of absorbent paper, and transfer the plants directly to it, as by so doing any injury to the plants is avoided and the whole can be transferred directly to the press on reaching home.

A knife or trowel for digging is of great use; the best is probably a trowel, in which the V-shaped grooved blade is driven directly into the handle. Prof. Maisch used to carry a convenient cane, with a nickel-plated handle shaped like a narrow grubbing hoe.

In collecting plants, care should be taken to collect those which are typical of the species, and yet variations from the typical form are also instructive and can be mounted by their side.

We always desire to obtain the inflorescence, and frequently also the fruit, as in some cases the latter is quite as, or more, important than the flowers, as in the case of the Umbelliferæ, where the distinction between the genera is based largely upon the fruit.

In the case of many plants, the radical (root) leaves should be gathered, as they are more characteristic than those growing upon the stem; e. g., shepherd's purse has the root leaves clustered, and pinnatifid or toothed, while the stem leaves are arrow shaped and sessile.

The root or rhizome should generally be gathered, as in a number of cases it is the officinal part of the plant, and it frequently has prominent characteristics; in the case of rare plants it is best not to do so, as some herbaceous perennials, like senega, have in this way been almost exterminated.

There is often quite a choice as to where your botanical excursion shall be made, different regions showing different floras. Those living in the neighborhood of Philadelphia will find quite a difference between the floras of Pennsylvania and New Jersey, and no herbarium of this region would be complete without representatives from both localities.

After the plants are collected, the next step is their examination and the identification of unknown species. To do this successfully, one should have a sharp penknife, pair of dissecting needles, pair of pincettes and a dissecting microscope, the best of the latter being one which has immovable hand rests, like Barnes', although Sayre's dissecting microscope, while not so convenient in the laboratory, can be used in the field as well.

In the examination of an unknown plant, the height, shape and epidermis of the stem should be considered, and whether endogenous or exogenous, although in most cases the venation of the leaves will show the latter just as well. The leaves should be examined as to phyllotaxy, venation, shape and size. The flowers should be examined as to the parts present, their size, shape, color, union, insertion, etc., and then vertical and transverse sections should be made, notes being made of the different observations.

When this has been done, the name can in most cases be speedily determined by means of the analytical key in the front of Gray's "Manual of Botany."

Beginners will find it easier to analyze regular flowers of fair size, such as the corn cockle (Lychnis Githago), which is frequently found in wheat fields, to the annoyance of the farmers; or what is still better is for the first times to take known flowers, like the apple blossom or wild rose, find the description in the "Manual," and compare it carefully. After this has been done a number of times they will be better able to proceed with unknown flowers.

Those with but little knowledge of botany will find Mrs. Dana's "How to Know the Wild Flowers," in which they are classified according to color, and many of them illustrated, an interesting book, while if they desire to increase their knowledge, they will find Professor Bastin's "Laboratory Exercises in Botany" a most valuable work. Gray's "School and Field Botany" (revised edition) is also an excellent work, not technical as the "Manual," and it includes many of the cultivated as well as wild flowers.

The next step is the preservation of the specimens. They should be dried between sheets of absorbent paper, with heavier sheets occasionally interspersed, sufficient pressure being made by means of weighted boards.

Perhaps a better arrangement for drying is to use for top and bottom an open frame or lattice work, each frame consisting of two layers of half-inch strips crossing each other at right angles, having a hook in the end of each strip. The sheets of drying paper are laid between the frames, and the proper pressure is made by means of a stout cord passing around the hooks, the whole being hung where there is a current of air.

In the case of hollow leaves like the Sarracenia (pitcher plants), or flowers like Cypripedium acaule (stemless lady's slipper), absorbent cotton should be placed in them to facilitate drying, and to preserve their outlines.

Specimens should be dried as rapidly as possible, to preserve their color and general appearance, and the driers should be changed every day for five days; still better results will be obtained by changing them two or three times during the first twenty-four hours.

According to Schroeder (Amer. Jour. Pharm., 1896, p. 132), heavy gray felt paper, saturated with a 3 per cent. solution of oxalic acid and allowed to dry, will preserve unchanged the color of the petals, and in most cases the green of the leaves.

When the plants are thoroughly dried they should be poisoned by applying a nearly saturated solution of corrosive sublimate with a soft brush, the plants being laid upon a flat dish, and afterward placed between driers until the alcohol evaporates.

Then follows the mounting of the specimens. Sheets of white paper, 11½ × 17½ inches, about 30 pounds to the ream of 480 sheets, are best for this purpose. They should be fastened to the sheets either by narrow strips of isinglass plaster or, better, directly by means of a liquid glue like Le Page's.

To the right hand lower corner of each sheet should be affixed a label, something like the following, which, for the purpose of illustration, is written out as it would be if affixed to the plant Chelidonium:

> Herbarium, C. B. Lowe.
> Bot. Name, Chelidonium majus.
> Synonym, Celandine.
> N. O., Papaveraceæ.
> Locality, Tulpehocken, 4/22/'96.

Each specimen or all of the same species may be inclosed in a sheet of white paper (of less weight than that upon which they are mounted.

All of the species of the same genus should be then inclosed in a genus cover of heavy manila paper.

The name of the genus, with that of the natural order, should be written in a large hand upon the lower left hand corner of the cover next the back. The name of the inclosed species can be written upon the lower right hand corner. The genera can also be numbered according to Gray's "Manual."

The herbarium should be preserved in a suitable receptacle, free from dust. This may consist of a cabinet, with shelves of the proper width and depth for the genus covers to slide in easily, or of a number of plain boxes with shelves 4 or 6 inches apart and doors which shut flush. The names of the orders can be pasted upon the shelves or affixed to the edge of the genus board, which contains a list of the genera of the order, and is inserted at its beginning.

* Read before the Pennsylvania Pharmaceutical Association, at Mount Holly Springs, June 17, 1896.—From the American Journal of Pharmacy.

[Continued from SUPPLEMENT, No. 1110, page 17747.]

PEAT BOGS AND MIGRATORY MOSSES.

By Dr. G. ARCHIE STOCKWELL, F.Z.S.

DURING the last century a bog in the vicinity of Churchtown, Lancashire, England, was observed to rise to a marvelous height—17 feet, it is said; soon after it sank suddenly, receding from its natural level in almost equal proportion to its former rise; it then moved slowly to the south, but fortunately without doing material harm or going to any great distance, thanks to the topography of the locality; having parted with its fluid constituent, it ultimately proved a valuable addition to the stony and sterile soil upon which it rested, so that some years later the latter yielded excellent crops.

Tradition recounts many movements of this character in Ireland, a country often denominated the "classic land of bogs." In 1833, at a depth of 14 feet, in the peat of Donegal, was found a number of ancient log cabins in excellent state of preservation, surrounded by the roots, stumps and prostrate trunks of trees, that gave mute evidence of the irresistible force that overcame them. There can be little doubt here was one instance of many in which villages have been overwhelmed by bursting moss. Unfortunately, the interiors of the huts were never examined, they being filled with the peat growth. A disastrous eruption occurred at Kilmaleady, in County Kings, in 1821; the bog in this instance rested upon clay foundation, and, strange to say, far from an excess of water having any part therein, the season had been one of excessive drouth, and the accident was brought about, doubtless, by undue cutting of turf, whereby the barrier in the direction in which the movement occurred was weakened. In 1697 the continuous rainfall of a very raw and unfavorable spring so flooded a large bog at Charleville, County Limerick, that its center was forced up to a great height, and "sounds proceeded from it resembling distant thunder, so that it was a matter of much query and wonderment what could be brewing underground." With the cessation of the noise the bog hill sank as suddenly as it had risen, and at the same instant the entire mass was observed to be in motion. "A wide and deep ditch separated it from some pasture land, but this did not prevent the morass sweeping onward with wavelike undulations, but unbroken surface, carrying the pasture land with it, only to deposit the latter in an adjoining meadow and there cover wholly with from 15 to 17 feet of muck—thus the meadow became pasture, and in turn the whole became bog; after which it would doubtless be somewhat difficult to determine the precise ownership, as the different parcels belonged to as many individuals. At the old site of the bog was left an unsightly hole, throwing up foul water and stinking vapors."*

In March 1745, after a violent storm, a "turbary"† at Addrigool, near Dunmore, Galway, which the turf cutters had just left, began to move, and floating to a piece of low-lying pasture near the river side, spread itself over an area of 30 acres. The choked river, a tributary of the Curramore, overflowed its banks, and very soon the fields in the vicinity were

* Encyclopedia Britannica Scottica, edition 1797.

† Where peat or turf is dug.

covered by a lake some 50 acres in extent; and before a channel could be excavated through the turf, the water had embraced 300 additional acres; and even a week after the cut had been effected a fifth part of the deluged land still remained submerged. This accident was repeated a little more than a century later in almost the same locality—October, 1873. A farmer laboring in his potato field caught sight of a brown mass making its way toward him, and leaving spade in ground started to warn his neighbors. An elevated bog three miles from Dunmore had burst, and it descended so rapidly that by the time the frightened peasant had fairly escaped his field, not only was the latter for the most part buried, but of the contiguous grain land only a few sheaves on a high knoll remained. In a very brief period of time the Stygian flood had overwhelmed several farm houses, and 200 acres of arable land to an average depth of ten feet, leaving behind it a great basin a mile and a half in circumference from which a thin stream of watery brown bog stuff continued to flow. Three weeks after the outburst this bog stream had attained a length of 2 miles and a breadth of from 400 to 600 yards, besides had sent 2,000,000 cubic feet of bog stuff down the valley. A letter from an eye witness, a resident of Dunmore at the time, states:

"The damage done is likely o be permanent in its effects unless, indeed, the foreign matter continues its locomotion and branches off to some locality where it will affect no industrial interest. As it is, a wide extent of capital land has been converted into a black morass; several families have been ruined, not only by the loss of their holdings and homes, but by the destruction of their crops, their fuel and other property that there was not time to save. It is pitiable to see one of these illfated tenements surrounded by the filthy ooze of the bog, with no trace of the green fields and cheerful harvest stubble which the occupants of the deserted dwellings looked upon from their thresholds only a few weeks ago."

It would seem as if the last fateful accident reported from Ireland, taken in conjunction with the foregoing, must "bring forth good fruit" by causing effective measures to be speedily taken to confine these quagmires within legitimate limits, as has been done in Scotland, England, and elsewhere. It is well understood that the continual removal of turf along the borders, and lack of effective drainage, renders each and every peat bog, especially when situate upon a height above the surrounding country, a source of continual, threatening and appalling danger.

English and Scotch mosses would seem to rarely convert themselves into movable property and set out upon their travels, yet such has been the case in more than one instance. In 1629 the great Monteith Moss in Perthshire, which with a little lake in the middle of it occupied a piece of gradually rising ground in the fertile district between the rivers of Forth and Teith, broke out, covering a vast area of territory, most of it cultivated wheat land, to a depth of 6 feet, with considerable destruction to animal life and the total ruin of some sixteen farms; the people fortunately received sufficient warning and fled. This great bog began a mile above the confluence of the rivers just mentioned, thence extended toward their sources for some four miles, with a breadth of sixteen furlongs, embracing upward of two thousand acres of the Blair-Drummond estate; it lay on a field of clay, a continuation of the rich carses (flats) in the neighborhood of Falkirk and Sterling. The greater part, averaging fifteen feet in depth, was known as "high moss," while the outlying and shallow portions were termed "low moss."* With this eruption the lake entirely disappeared, its placed being usurped by peat growth; but this morass will never again yield fuel, or become a source of danger, inasmuch as systematic reclamation was undertaken by Lord Kames, after his espousal of Mrs. Drummond, so that by 1776 all the "low moss" had been turned into arable land; nine years later more than half the "high moss" had disappeared before like efforts; in 1797 every portion was devoted to agriculture in some form, and boasted 620 inhabitants and 69 brick habitations.

Another great bog was that of Kylemore in Sunderlandshire, reclaimed by efforts of the Duke of Sutherland; and the luxuriant hay crops of the present day afford a great contrast to the dark and dreary devastation that obtains to many Irish estates that are equally amenable to improvement. Thus is exemplified the wide gulf between Scotch thrift and Irish indolence.

Again, during the heavy rains that prevailed in August, 1861, a farmer, dwelling near the little village of Slamannan, in the extreme northern portion of Lancashire, close to the border of Sterling, looking out from his door early one morning beheld some twenty acres of Auchingray Moss part company with its clay bottom and float away three-quarters of a mile, to the utter ruin of many acres of grain lands and potato fields over which it spread.

The largest fen known to England was Chat Moss, which in the far away days of the much married and often widowed "Bluff Harry" burst—as the antiquarian Leland tells us—"within a mile of Mosley Haul, destroying much ground with moss thereabouts, along with much good fresh water fish thereabouts, first corrupting with stinking water Glasbrook, which was carried into the Mersey, and the Mersey River corrupted, carried the rolling moss, part to the shores of Wales, part to the Isle of Man, and some even to Ireland. And in the very top of Chateley Moor, where the moss was highest and broke, is now a plain, fair valley as ever in times past, and a rill runneth in it, and pieces of small trees be found in the bottom.' And thanks to the genius of Stephenson, this great bog, originally six miles long, half as broad, from ten to thirty feet deep, and embracing seven thousand acres, is now only a memory, its place being usurped by green fields and thrifty habitations. It consisted of a mass of pure vegetable matter without any admixture of sand or gravel.

Perhaps the most notable of all the mosses that are recorded as migratory is that of Solway, which occupies a flat area some seven miles in circumference—about sixteen hundred acres—on the western confines of England and Scotland, in Cumberland, near the Netherby, made famous by Scott as the exploit of "Young Lochinvar." Pennant, the naturalist, in 1768 described Eskdale—the valley below the moss—as "a beautiful tract of cultivated land." Four years later, after the bog had burst its boundaries, he wrote of this same region as a "dismal morass." Strange to say, the exact date of this irruption is a matter of question, various authors describing it as occurring on the 15th, 16th, or 17th of November, some giving the year as 1771, others as 1772. Of the facts, however, there can be no doubt.

To fully appreciate the magnitude of the catastrophe it is necessary to understand the topography of the locality. Here, along the northeast side of the River Esk was a vale about a mile in breadth, bounded on the northwest by a steep bank from thirty to fifty feet in height, from the top of which the ground rose in easy ascent for some eighty rods, where it terminated in the morass, which in turn extended between two and three miles from north to south and a mile and a half east and west; it reached even to the highlands bordering the River Sark. In many places the top of the moss was more than eighty feet above the level of the valley; and it is now known that the solid ground from the top of the bank above the vale was continued in the same direction under the moss for a considerable distance; and the latter at the place where it broke bounds was inclined toward the sloping ground.

Near the edge of the moss was a coulé or hollow known as "the gap," some thirty yards in depth where it entered the vale, and down which ran a small beck or burn that, often dry in summer, derived its supply solely from the filtrations of the bog.

About ten or eleven at night, when all the streams were prodigiously swollen, and the quagmire itself, like a great sponge, filled with water—partly from the springs below it and partly as the result of the heaviest rainfall that had been known for two centuries—a large body of moss broke out. By the pressure of the water behind it, accumulated as in a great reservoir, aided by the trend of the land, and flowing burn, an enormous quantity of pasty, sticky muck, and half concrete peat, was forced down the "gap" and carried into the Esk valley, over which it spread with considerable rapidity, resembling in its mode of progress a current of lava and continuing in movement for some hours. Thus during this one night eight hundred acres of arable land were more or less damaged, and more than half the area of Eskdale covered to a depth of from three to twelve feet. Altogether some thirty-five cottages were overwhelmed, most to the very eaves or thatch, and a vast amount of stored and stacked grain destroyed, though, fortunately, no lives were lost. Chambers* thus tells the tale:

"A farmer living close by the moss, hearing an unusual noise, went out of doors, lantern in hand, to discover the meaning of it. He saw a small dark colored stream flowing toward him, and for the moment fancied it came from his own dunghill; but the stream growing to a deluge, he ran as he never ran before to rouse up all within hail, with the news that the moss was out. Some received their first intimation of the disaster from the entrance of the foul tide into the houses, and these sound sleepers had to wait till daylight ere they escaped through the roof, with the aid of outside friends. Still there was cause for congratulation, for although buildings had been swept down, cottages filled from floor to roof tree, and good land overwhelmed beyond redemption, no man, woman, or child had been done to death by the unlooked for eruption. The cattle had not escaped so well, many beasts being suffocated in their sheds. One cow, the solitary survivor of eight, after standing up to her neck in mud and water for sixty hours, had appetite enough to eat heartily when delivered from durance, but refused to touch any wate', nor could she even look at it without manifest signs of horror!" This last touch regarding the cow is so pathetic and absurd that it deserves place, if for no other purpose than to illustrate the simplicity of the author, who nevertheless was a man of more than ordinary scientific note.

After the treacherous mass ceased to move, two considerable streams continued to flow from the heart of the bog, and joining the burn, reformed the channel of the latter, which with little assistance from the people made its way through the great body of the newly slipped moss. The latter was thus in great measure drained, so that when fair weather came at the end of the month, the irrupted moss fell several feet and settled in a firm and solid body which was soon made arable again.

Before this irruption the bog had always obtained a bad name; it not only vibrated dangerously to the tread of man, but was accredited with having on many occasions proved the untimely sepulcher of those who tempted its unstable surface—it had also been the means of destroying numerous domestic cattle; and while it was possible for an expert familiar with all its peculiarities to traverse with caution in nearly all directions, a pole pushed through the crust would with almost certainty sink into soft muck for a distance of twenty-five to thirty feet. It was in this treacherous morass, in 1542, that a troop of Scottish horse was engulfed, to the last man, while fleeing from the army of Henry VIII, after the battle of Solway; and though this was long deemed a doubtful tale of traditionary origin, it was in a measure confirmed, in the early part of the present century, by the exhumation of a man and horse, both in complete armor, at the very spot where the accident was said to have occurred.

Strange as it may seem, the localities that abound in peat bogs and mosses, far from being unhealthy, oftentimes are quite the reverse, sometimes renowned for their salubrity. The watery exhalations are neither so abundant nor noxious as those from ordinary marshes, which are rendered prejudicial by a vigorous vegetable growth that, as soon as the waters are lowered by evaporation or drainage, undergo most rapid putrefaction. Indeed, peat bogs are not, as might be surmised from their intense blackness and slimy nature, masses of putrefying matter, but are merely the outcome of a slow decomposition of chemical character, whereby cresols and other empyreumatic substances are found, along with hemic, phosphoric and sulphurous acids; consequently they are truly antiseptic in character,† as is evidenced by the fact that they preserve animal matters for immeasurable spaces of time, frequently transforming into adipocere, as in the case of the trooper and horse just mentioned. Bodies in perfect preservation have repeatedly been found embedded, that from characteristics of clothing and surroundings gave evidence of having been inhumed for several centuries.

In January, 1747, the corpse of a woman was taken from a moss in Lincolnshire six feet below the surface. The head and feet were nearly bent together, and the skin, nails and hair exhibited most excellent preservation. Upon it were shoes or sandals, each formed of a single piece of oxhide, made to fold about the heel and fit the contour of the foot, and piked with iron, such as Chaucer described as being worn by ladies of quality in his time. Half a century before, a shoe, presumably of even earlier date, was found in an Irish bog that exhibited considerable attempt at ornamentation; it was neatly hand stitched and, except for stains, as well preserved as if only buried for twenty-four hours. Again, both in Irish and Welsh bogs, a form of butter known as rouskin has been found, packed in the hollowed trunks of trees where it had lain hid so long as to become hard and friable, yet was not entirely devoid of unctuous qualities; but such have invariably been buried at considerable depths, and none so far as known ever been found where the peat moss had not become distinctly carbonaceous.

* Domestic Annals of Scotland, by Robert Chambers.

* Domestic Annals of Scotland.

† For this reason peat has several times been suggested as affording an ideal dressing for wounds and for employment in surgery.

LAKES.*

LAKES short lived and ephemeral (compared with rivers); and may be traced from first formation to final disappearance.

Lake basins formed (1) by depressions on new land surfaces; (2) by atmospheric weathering; (3) by rivers, both by erosion and deposition of barriers; (4) by glaciers, ice dams, morainic dams, excavated rock basins; (5) by volcanic agencies, lava dams, crater lakes; (6) earthquakes and landslips; (7) by movements of the earth's crust.

HISTORY OF THE GREAT (LAURENTIAN) LAKES—LAKE AGASSIZ.

"Lake" is a very comprehensive term, covering waters gathered and held from very different sources. As a usual thing, the bottoms of lakes are below the general drainage level adjacent. Between the pond of a few acres and Lake Superior there is merely a difference of size, not of principle. The smaller bodies of water may be held securely above the general drainage level of the country; large bodies never are.

Lakes are transitory and ephemeral, though not so in comparison with the events of human history. No one connected with the commerce of the great lakes need worry over the fact they will some day disappear; such, however, must be their fate ultimately. As mountains are short lived compared with plains, so lakes are short lived compared with rivers.

A very ancient topography is invariably marked by the absence of lakes. Large or numerous lakes are conspicuously absent from land surfaces which have long been exposed to the degrading agents without any particular sudden change. A lake map of the United States shows a vast difference between the North and the South. The Northern States are crowded with lakes—Wisconsin and Minnesota having them by hundreds. There are more lakes in Massachusetts than in the whole South—a difference in nowise due to climates as at present constituted, but to our Northern topography being all young; every bit of it has been remodeled by the great ice sheet lately covering it, while this ice sheet did not extend into the Southern States; consequently the Southern topography is old, and, with comparatively few exceptions, what lakes they had have disappeared.

Throughout the length and breadth of the Appalachian range scarcely any lakes occur. In most mountainous regions, world over, lakes abound; yet, in an old range like the Appalachian, lakes are wanting. They occur in the Rocky Mountains, the Sierras, the Alps, the Himalayas; but these ranges are all of much later date. Sir Charles Lyell, the great geologist, was struck by this absence of lakes from the Appalachian range when, many years ago, he came to this country. He was accustomed to mountain regions where lakes abounded. He could not understand it, because the secret of lake formation had not, at that time, been worked out.

There are many methods of lake formation. First, the lake of a land surface recently upheaved above the sea, as in Florida, which, geologically, is young. There never can be one dead level; depressions must form, and into these, before any drainage system is well established, the water will gather and produce lakes. Such lakes are comparatively rare, there being few surfaces which are youthful to this extent.

Lakes, again, arise from atmospheric weathering. Rock destruction by aerial agents takes place never uniformly, but always more rapidly along certain lines than others, in certain places more than others; so when any denuding agent comes along and sweeps clean the rock surface of detritus, a very irregular surface will be left.

A domestic illustration will show the irregularity of rock disintegration. A 4 ft. deep trench was cut through my yard for sewer connection. For 20 ft. from the street sewer the solid rock came within 2½ ft. of the surface. We had to blast that distance. The rock was flinty hard. From the 20 ft. on the digging was through rotten rock, readily handled with pick and shovel. Not one blast in the whole distance; yet the rock the same all through. The further away from the street, the deeper lay the solid rock; and at the far end of the trench the excavations went down 20 ft. without reaching the unaltered rock. There was no difference in the rock; it was merely that the disintegrating agents had in some way scooped out a great hollow there—not removing the material, but disintegrating the rock 35 to 40 ft. deep probably; while out along the street the solid rock came within 3 ft. of the surface. Had a glacier come along sweeping everything movable before it, we should have had a saucer-shaped depression in the solid rock with a high lip on the street side and another one off in the other direction perhaps a quarter of a mile. That depression would have eventually filled with water and given us a little lake. This illustrates on a very small scale what occurs every-

* Condensed for the SCIENTIFIC AMERICAN from a lecture at Wagner Institute, Philadelphia, by W. B. Scott, M.A., Ph.D., Professor of Geology at Princeton University.

where on a large scale; namely, this differential in the structure of the rock, so that when, at certain places and along certain lines, the debris is swept out, and the solid rock revealed, you have the very irregular surface in which lake basins are formed.

Another way is by rivers. Many lakes are merely extended river basins flooded, arising in a variety of ways. Usually some sort of a dam is thrown up at a point in the stream which will produce a lake. Sometimes this dam is the delta of a side stream, the tributary bringing in a good deal more debris than the main stream can carry off; consequently, a barrier is there erected producing a lake. Not far below St. Paul, in the Mississippi River, is a very beautiful lake (Lake St. Peter)—merely an expansion of the Mississippi—5 miles across, 5 miles long. The Chicago, Milwaukee and St. Paul Railway runs along its western shore. The lake was thus formed: the Mississippi comes down in one direction, wearing out a great valley several miles wide, with high bluffs on each side; the Chippeway River comes from the east and throws out a delta into the stream which acts as a dam at a point where the valley is narrow. Consequently, dam shuts up valley and stream widens out into a great lake. That is only one of a thousand ways of producing lakes in the course of streams.

In the course of time, when the Chippeway has cut down to base level and does not bring in the great load it used to, the Mississippi will be able to take away all that the Chippeway brings and to dig away part of what the Chippeway brought before. The Mississippi will eventually cut down through that barrier and the lake will be drained away just exactly as, taking a local millpond and cutting a trench through the dam, you drain the pond. Still another way is by movements of glaciers, which sweep away the loose soil and disintegrated rock, leaving behind irregular surfaces and basins in which lakes would form. Glacial erosion is one of the most important methods of lake formation; but then glacial deposition is equally important. Although glacial deposition probably rarely makes lakes on a very large scale, it makes them on a smaller scale. A valley having moraine material deposited at its lower end will, when the ice sheet has disappeared, become the site of a lake. A terminal moraine is rubbish which the glacier dumps at its lower end—a great crescentic mound with the concavity upstream; and as the glacier retreats you get a series of these concentric mounds, one behind the other—each one of the terminal moraines representing the hole which the glacier made in its final retreat; so that in a narrow valley the terminal moraines will eventually dam the valley from side to side, and if a stream flows there, it will be dammed back into a lake.

Another way is by means of lateral moraines. With a glacier flowing past the end of a valley the lateral moraines piled up will likewise form dams. Then, besides these lakes which exist as the result of glacial deposition long after the glacier itself has disappeared, we have temporary and ephemeral lakes due to the dams formed by the ice itself. Very extensive lakes were formed in this way in the glacial period; and we see little lakes of this kind formed now, where a great flood or stream of ice flows past the mouth of a valley and acts as a dam to hold back the drainage of that valley, thus filling it up as a lake.

Little lakes of this kind are found through the Alps, and Alaska, and in Greenland, and in all other glacial regions, where the great body of ice itself acts as a dam; but, unfortunately, these are apt to be periodical lakes; they melt a tunnel for themselves through the ice, away under it, and often empty out with disastrous results.

A little lake in Switzerland has been suddenly emptied in this way quite a number of times and always with a tremendous and destructive pressure, causing the loss of a great deal of life and property.

Still another way is by volcanic agency. We have, for instance, a great volcanic cone, the usual disposition of which is that by a terrific explosion it is blown off into dust, practically annihilating it; or a fresh influx of volcanic heat may so melt all the underlying part that the top simply falls in. The usual way is by explosion, and that makes a crater ring-formed; the ring may be ten miles in diameter, inclosing an area, roughly speaking, of a hundred square miles; this ring may be filled with water, thus giving rise to what is called a crater lake, because occupying the crater of an extinct volcano. One of the most remarkable of these is in the Cascade Mountains, called Crater Lake, and six miles in diameter.* There are plenty of them in various parts of the world.

Still another way in which volcanic agencies may produce lakes is by a lava stream damming up the mouth of a valley, as was done by ice in glacial days; the difference being in the indestructibility of the lava barrier. Lakes of this kind abound in our West, especially in Eastern Oregon and the adjoining parts of Washington, Idaho, California, and Nevada. Here the whole country has been overwhelmed in the great lava floods and many small lakes have been produced by the damming of the valleys and subsequent filling with water.

Earthquakes produce lakes in two ways: one being that the lava, flowing in a deep, narrow valley, is dammed by having a fold of the earth thrust up across the mouth of the valley; a fold of a few feet being enough to produce a very effective dam and thus convert a stream into a lake. A number of lakes of this character were formed by the Japanese earthquake of 1890. The earthquake may also do the same thing indirectly. One of the most important geological effects of earthquakes is the land waves or landslides they produce. Steep hills, by the shaking they get, throw down innumerable millions of tons of rock and earth. The great landslide of 1880 at Elm, Switzerland, displaced 12,000,000 cubic meters of rock to an average distance of 2,000 feet. In mountainous regions a great many of the valleys are occupied by streams, and many of them are narrow or have narrow mouths, emptying out through narrow, deep gorges. A landslide, by tumbling a huge mass of rubbish down the mouth of this gorge, would thus back the water up, producing a lake where formerly had been a stream.

All the above-considered methods of lake formation apply to small lakes a few miles, at the most, in diameter. The great bodies of water like our great Laurentian lakes (through the St. Lawrence to the Atlantic); the great lakes of Africa; the salt lakes of the interior of Asia (like the Black and the Caspian, the Caspian being a lake without outlet, brackish, considerably larger than Lake Superior, really the largest body of inland water on the earth); lakes of such gigantic size are not made in any of the ways so far considered. The particular method of producing gigantic lakes of this character is by the movements of the earth's crust itself. They alone occur on a sufficiently large scale to form the great depressions necessary for these vast bodies of water. An unequal movement of the earth's crust will produce depressions at certain places, and these depressions become filled with water and give rise to these vast lakes. The smaller lakes are those which, more than anything else, are connected with glacial agency one way or another. You can draw the line of the terminal moraine, showing the extension of the old ice sheet, and you are simply astonished at the difference between the number of lakes in the region lying north of the terminal moraine entirely (the region which was glacial) and the region lying at the south of the terminal moraine (which was not glaciated). In the one case you get lakes by the thousands; in the other case, not at all. In the whole south of the United States there are no lakes at all, practically—one or two at New Orleans, like Lake Pontchartrain; but you will find more in a single county of Minnesota than all the Southern States. This is due to the fact that the glacier has rejuvenated the northern topography. The old topography is pre-eminently without lakes; lakes have disappeared by the cutting down of their barriers or by the filling up of their basins. Small lakes are removed in either way. A little bit of a lake a few acres in extent is frequently choked up by vegetable matter, and thus converted from a lake into a peat bog, and then into a swamp, and then into a meadow. Somewhat larger lakes are filled by the deltas of the streams that flow into them.

Great lakes are not filled in that way, but are removed by the cutting down of their barriers; and yet even these require a very long period of time for their removal: First, because the streams flowing out of lakes are remarkably clear—wonderfully clear. Lakes act as settling basins, and clear, pure water has very little power in the way of cutting out rock. Further, these lakes, generated by movements of the earth's crust—filling actual depressions formed in the crust—are very apt to be below sea level, and therefore below base level. The bottom of Lake Superior is several hundred feet below sea level; and no stream flowing out of Lake Superior is going to be able to saw its barrier below the bottom of the lake, because it is already below base level; and Lake Superior, for example, is going to be a very long-lived lake. In the course of the centuries the barrier will be cut down to base level, and thus the lake very greatly reduced in size, and then, eventually, it will be filled up with material washed in from the banks and brought in by the tributary streams. That will be the end of Lake Superior.

There is a very important difference between fresh lakes and salt lakes. Salt lakes invariably imply an arid or dry climate. If you could bring the Great Salt Lake of Utah and set it down in eastern Pennsylvania, you couldn't keep it any length of time. The basin in which you would put it would gradually fill and fill until it would rise to the level of some point in its banks, when, securing an outlet, it would freshen at once.

Salt lakes now existing imply arid climates. They are found in the great basin region of our West; and we get them in Palestine (exceedingly dry); in the central Asiatic region (exceedingly dry—the Caspian, especially, along whose eastern shore is one of the most arid districts in the world).

Salt lakes are of two origins: First, those which are merely cut off arms of the sea, and which were salt from the very beginning; and secondly, those which are due to the indefinite concentration of river water by means of evaporation. River water, like all other natural water, is not pure. It contains a good many things in solution—carbonate of lime, more or less sulphate of lime (gypsum), invariably more or less chloride of sodium (common salt), smaller quantities of chloride of magnesium, chloride of calcium, etc. Provided you could keep on boiling these things down long enough, you would invariably get a salt lake. The water being distilled off all the time by the action of the sun, no matter how dilute the solution with which you begin, you must eventually end up with a saturated one. Great Salt Lake and the Dead Sea are so saturated with brine, they are depositing salt all the time—at least in summer, when evaporation is greatest and feeding streams are least. In the spring, when the sun is melting the snows, the streams rise and evaporation is usually checked, when the deposition of salt is checked and the water of the lake is slightly freshened.

In Great Salt Lake the water is so dense that swimming in it is one of the most remarkable experiences imaginable. You can stand up straight, with your shoulders upward, and you are out of water; and while it is impossible to drown there in the ordinary sense, it is very easy to get into trouble in it for people who don't know how to manage themselves, because this water is intensely bitter, and if you get any of it in your eyes or throat, it is like a dose of liquid fire. The difficulty with novices who don't know how to swim is that they turn the wrong way up; the head goes down and the feet up; they suffocate and drown in that frightful stuff, simply because they can't keep the head up. A good many people have lost their lives in that way. To a person who can swim it is perfectly easy to keep right end up; it is a sensation of being absolutely without weight. It would be like flying, if one could move fast enough. Though one's movements are slow and sluggish, the sensation is very extraordinary, and all due to the excessive density of the water, and that in turn to the evaporation and to the aridity or dryness of the climate.

Lakes, as we have seen, have a history. They can be worked out sometimes with a great deal of accuracy, sometimes only to be guessed in their broad outline.

Lake Agassiz was a very large body of water in Manitoba, a Canadian province, adjoining parts of North Dakota and Minnesota. It had a north and south diameter of some 700 miles—very much larger than any of the five great lakes of the present time.

Lake Agassiz was formed in this way: The great ice sheet which came down from the north was not a sheet, but a series of great glaciers. For these there were three principal areas of distribution: The first of them was in Labrador, the second in the highlands west of the St. Lawrence River (south of Hudson's Bay), the third was the mountain ranges of British Columbia. Now these three great flows of ice did not come down simultaneously; they reached their maximum extent at different times. The Kiwatti glacier swept down over Manitoba into the Upper Mississippi valley into Minnesota, and probably extended down as far as Iowa; then it commenced to retreat, and while it was retreating, the great Laurentian glacier, from Labrador, was coming in from the east. There came a time when the Kiwatti glacier formed a northern dam and the Laurentian glacier formed an eastern dam, the two standing nearly at right angles; and in this great dammed up space was formed Lake Agassiz. It rose and rose and rose until it could overflow the barrier to the south, and thus discharge into the Mississippi River by means of a river which has now entirely disappeared, and was known as the River Warren, after the late Gen. George K. Warren, who first discovered it. This lake continued until the glaciers up there retreating, one to the northward and the other to the eastward, separated and left a space between them. Then the drainage way to Hudson's Bay was opened again and the lake was very rapidly drawn in that direction. We can find perfectly well the old beach line and the old drainage outlets by which this drainage of Lake Agassiz was completed. The old terraces and beaches are there to-day, perfectly plain; the level bottom of the lake is clearly shown; the great valley and plains of the Red River of the North—in fact, the whole history of the lake has been made out with perfect clearness and definiteness.

Lake Bonneville, in Utah (named after Capt. Bonneville, one of the first explorers of that western country), occupied nearly all of eastern Utah in the pleistocene period. This lake had about four periods in its history, corresponding to the two periods of drought and two of rainfall. In the first period of rainfall the rainfall increased until the lake gradually acquired the area of 19,000 square miles, filling the whole of the depression of eastern Utah with water to the maximum depth of a thousand feet, until an outlet was found in the north in the Snake River valley, and through the Snake into the Columbia and thus to the Pacific. Then came a time when the climate of the country changed and evaporation exceeded rainfall; and we find the lake steadily shrinking until it became dry. That was the second period. The third was where the rainfall again increased until the lake assumed its old extent and even exceeded it, and then had its outlet again to the north. After this second period of maximum rainfall came another period of minimum rainfall, when the lake again dried up, and Salt Lake today is one of the remnants of old Lake Bonneville.

Salt Lake is about one-twentieth the extent of Lake Bonneville. At the left hand side of the Wahsatch Mountains you can see the lines of the old lake shore of Bonneville Lake for many, many miles.

The Yellowstone Lake is a rock basin. Not very long ago (from a geological point of view) it had a drainage the other way—the old outlet leading southward across to Ocean Pass down through a comparatively insignificant river into the Pacific, the traces being still clearly visible; whereas, the present outlet is north by way of the Yellowstone River into the Missouri and thus into the Atlantic watershed. This is due to a change in the movement of the earth's crust, but the basin itself is partially due to atmospheric disintegration.

A glacial lake in Greenland is held in place by a great ice dam. Into such lakes are icebergs born and launched. Every now and then these lakes are drained by little tunnels under the ice, and then there is mischief to pay.

Eagle's Nest Lake, in the Adirondacks, does not differ in principle from the western lakes we have seen. It is a glacial lake, a rock basin lake, and the action of the glacier is everywhere visible about the shores of it. These lakes are scattered through the Adirondacks by the hundred, and there are more of them in that single little region than you get in the whole South, simply because the South is a region of comparatively ancient topography, not having been glaciated, and the North of recent topography, having been rejuvenated and revolutionized by the action of the ice sheet.

Lake George is an ice basin—not a mere dam of moraine material or anything of that kind. It is yet more beautiful and picturesque than Lake Champlain. These lakes have also, in addition to their scenic and geographic interest, an extraordinary historic interest, because for over a century and a half the struggle for supremacy on this continent between the French and the English race was more than anywhere else fought out on the shores of these lakes. Every foot of the shores of Lake George and Lake Champlain is historic ground. This was the great highway between Canada and the English colony; it was about the only way they could strike one another so as to hurt. Everywhere else they were separated by a vast wilderness excessively difficult to traverse, but by way of Lake George, Lake Champlain and the rivers they could get at one another, and this has been their natural meeting ground.

Schroon Lake, N. Y., in the neighborhood of the Catskills, is a rock basin, due partly to folding movements of the earth's crust, partly to the gouging out of the loose soil by the action of the great ice sheet.

Devil's Lake, in Wisconsin, is one of the glacial lakes of that part of the country, being remarkable for its circular form and for the very curious character of the cliffs that border it in many places.

Nearly the whole of Ireland was submerged under the great ice sheet, as was the larger part of Great Britain in general; and Lake Killarney was formed on the same principle as the Twin Lakes, in Colorado, Yellowstone Lake, Eagle's Nest Lake, Lake George and the rest of them, as seen in the United States.

Loch Avon, in Scotland, is also a rock basin—exactly the same kind of lake as Gold Lake, in Colorado.

Norway is pre-eminently a region of glaciation. It not only was glaciated not long ago, but even yet has the largest glaciers of Europe. The Norwegian ice streams were on a vastly larger scale, more impressive and more beautiful than the glaciers of the Alps. Such a region as this necessarily abounds in lakes with rock basins.

* See SCIENTIFIC AMERICAN, December 5, 1896.

The Dead Sea, in Palestine, is even more horrible in character than Salt Lake; its water is even heavier—lying as it does in a desert; and the Dead Sea has been for ages the very synonym for desolation and horror. As to the tradition that the Dead Sea is the site of Sodom and Gomorrah, this is a point on which I have no information. One of the most remarkable things about the Dead Sea is its lowness. The surface of this lake (because it is a lake) is 1,308 ft. below the surface of the Mediterranean; and if a channel could be cut to connect the Mediterranean with this great valley, it would be filled up with salt water to a height of over 1,300 ft. above what it is at present. That would no doubt have a very ameliorating effect on the climate of that whole country.

Lake Geneva, in the Swiss Alps, encircles the Castle of Chillon, into whose popular history a good deal of humbug enters; as the romantic events which Byron celebrates in his "Prisoner of Chillon" never took place there or elsewhere. The color of the water is the most exquisite sapphire blue; and its wonderful blue color arises, as Tyndall has shown, from the presence of infinitesimal particles of glacier mud, distributed through the lake in infinitesimal size, in such small quantity as not in any way to detract from its clearness, and at the same time to give to the lake this wonderful blue to which so much of its fame and beauty are due.

At a time when northern Europe was buried under the ice, the Alps were under the ice sheets, only the most northern peaks projecting above it.

Interlaken, Switzerland, was once a single lake which has been gradually cut into two by a stream delta. The whole plain on which the town lies is delta. Eventually, though very slowly, the lakes will be obliterated by the growth of this great Interlaken delta.

In the Engadine occurred the Little Cornaro glacier and lake—same sort of thing exactly as the Gold Lake in the Rocky Mountains, only slightly different in detail.

Among modern lakes, the most modern instance prominent is the one formed in Japan, due to the earthquake of 1890. The case was that of a narrow valley, with a little stream flowing in it; and this earthquake threw up a transverse breast of earth that made a dam at the lower end of the valley; the water backed up a mile in width for several miles in length; and thus we have a new lake formed really before our eyes.

COMPLETION OF THE RUE REAUMUR, PARIS.

THE completion of Rue Reaumur, at Paris, was an operation long ago decided upon, but, despite the great interest that the opening up of this great artery presented, there was some hesitation in proceeding to carry out the project, on account of the great expenses involved, such, for example, as those that would be incurred in the taking possession of valuable property and in the indemnification of tenants.

Two facts, however, hastened the realization of this important project: first, the ever increasing obstruction of the great boulevards, and, second, the weight of public opinion, which made itself felt with the municipal council of the city in view of the construction of a rapid transit railway, a tunnel for which it was thought might be constructed concurrently with the opening of the street.

The completion of the street was decided upon on the 18th of January, 1892, and the work is now about finished. In order to facilitate the ulterior construction of the railway, all the sewers had to be installed

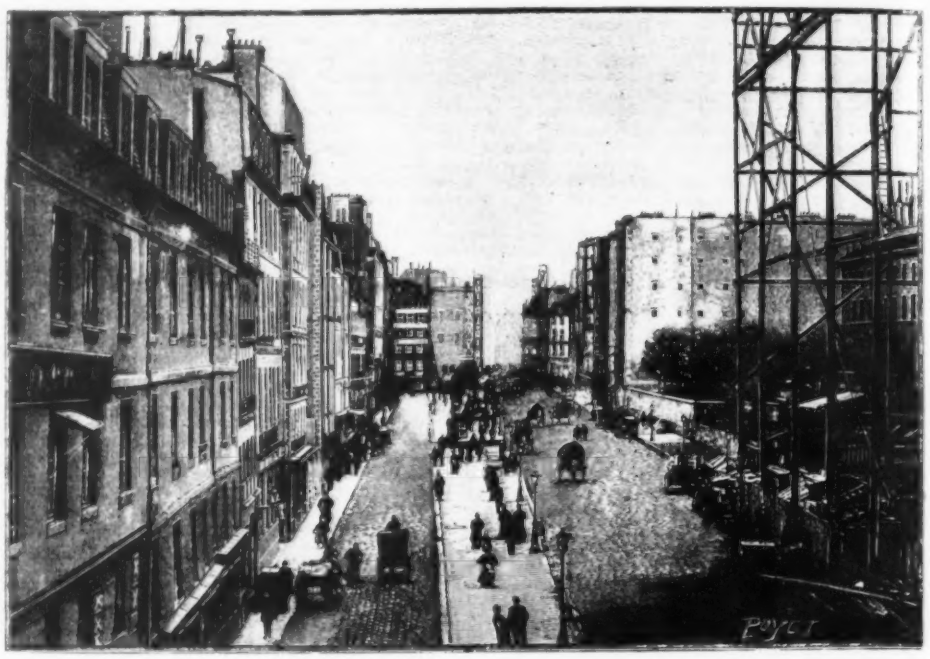


FIG. 1.—GENERAL VIEW OF RUE REAUMUR, BETWEEN RUES SAINT DENIS AND PETITS CARREAUX.

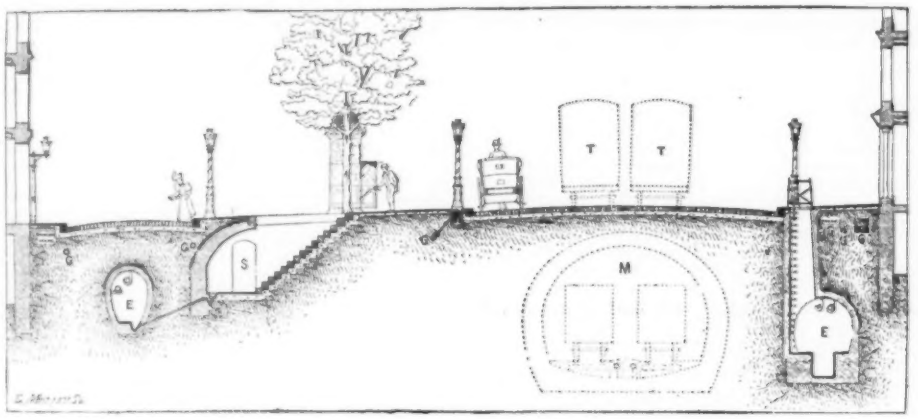


FIG. 2.—TRANSVERSE SECTION OF RUE REAUMUR, BETWEEN RUES SAINT DENIS AND PETITS CARREAUX.

FIG. 3.—OPENING OF RUE REAUMUR—VIEW OF THE STREET TAKEN DURING THE PROGRESS OF THE WORK.

outside of the external gage of the tunnel, so that they would not have to be shifted later on.

The normal transverse section of Rue Reaumur admits of a 39 foot roadway and two 13 foot sidewalks, representing, in all, a width of 52 feet. But in the part comprised between Rues Saint-Denis and Petits-Carreaux (Fig. 1) for a length of 960 feet, it became necessary, because of the incorporation of the old roadway of Rue Thevenot, to modify the normal profile in such a way as to give access to the buildings preserved on the uneven numbered side. In this part, therefore, the cross section (see Fig. 2) admits of a 13 foot sidewalk, a 39 foot roadway, an earthwork platform of variable width, then a 16 foot roadway, and, finally, a 5 foot sidewalk along the houses of Rue Thevenot. By reason of its width, the platform could have received a line of trees, but, inasmuch as Rue Reaumur is not planted in its other parts, the trees were placed in an alignment of 16 feet from the curbs, so as not to injure the perspective. Besides, advantage was taken of the surface disposable to install a coach station, urinals, benches, newspaper stands, and two subterranean chambers for the street cleaning service. Parallel with the roadway, these chambers (S) comprise two parts. In one of these, which is provided with a metallic flooring and terra cotta flagging, are arranged the tools of the street cleaners and duplicate materials, such as brooms, rubber scrapers, picks, shovels, etc., while the other part is wholly of masonry and serves for the storage of salt for the rapid clearing of the streets after a fall of snow. The quantity of salt stored in each chamber is 88,000 pounds.

In streets of equal width it is customary to establish two sewers, one for each sidewalk. The type usually employed is of elliptic section and has a height of 6¼ feet under the key. It is provided with a banquet 16 inches in width, upon which the sewermen walk, and a drain trench 10 inches in depth. This type (E, to the left) is applied upon the uneven numbered side of the street. On the even numbered side certain conditions rendered it necessary to construct a junction collector between Rue Montmartre and Boulevard Sebastopol. This collector (E, to the right) comprises a drain trench 30 inches in width and 28 in depth and two banquets 20 inches in width, and has a height of 7¾ feet under the key. As sewers of this size cannot be conveniently cleaned by hand, the collector will be provided with sewage cars that run on rails formed of angle irons fixed to the edge of the drain trench. The construction of the sewers presented great difficulties, due to the proximity of the buildings preserved and to the extremely varied nature of the subsoil.

Like all similar great thoroughfares, Rue Reaumur will be paved with wood upon a concrete foundation. As it would have been imprudent, by reason of the nature of the subsoil, to construct the definitive roadbed at once, a temporary bed has been formed with stone derived from the old pavements. The final pavement will consist of pitch pine; while at the places of intersection of other streets hard exotic will be employed.

The sidewalks are asphalted, but the asphalting is done only in measure as the curbs are constructed. The curbs, which are of granite, are 12 inches in width and 12 in height, 6 inches of which are above the gutter. They are now laid upon a masonry foundation with a mortar of hydraulic lime. After the laying of the wooden pavement is begun, they will be regulated anew, and advantage will be taken of the raising of them to install them upon a concrete foundation, which will rise behind the curb in order to increase its resistance to the thrust of the wooden pavement. It is well known, in fact, that under the action of rain and the water used for washing streets, a wooden pavement swells and tends to exert a thrust upon the curbs.

In each sewer there is a double distribution of spring and river water. The mains have diameters varying from 4 to 12 inches. They are of cast iron, with ring joints for those of diameters greater than 4 inches, and socket and spigot joints for those of 4 inches. At about every 120 feet, hydrants for washing the streets are placed under the sidewalks, and, in addition to these, there are installed at every high point hydrants to permit of slushing the gutters.

The lighting of the street is assured by butterfly burners that consume 5 cubic feet of gas an hour and are inclosed in round bronze lamps. The lamp posts, which are of copper colored cast iron, are 10 feet in height. They are arranged in quincunxes, with a mean spacing of 60 feet. At the street corners the lighting is reinforced by recuperating burners that consume 19 cubic feet of gas an hour.

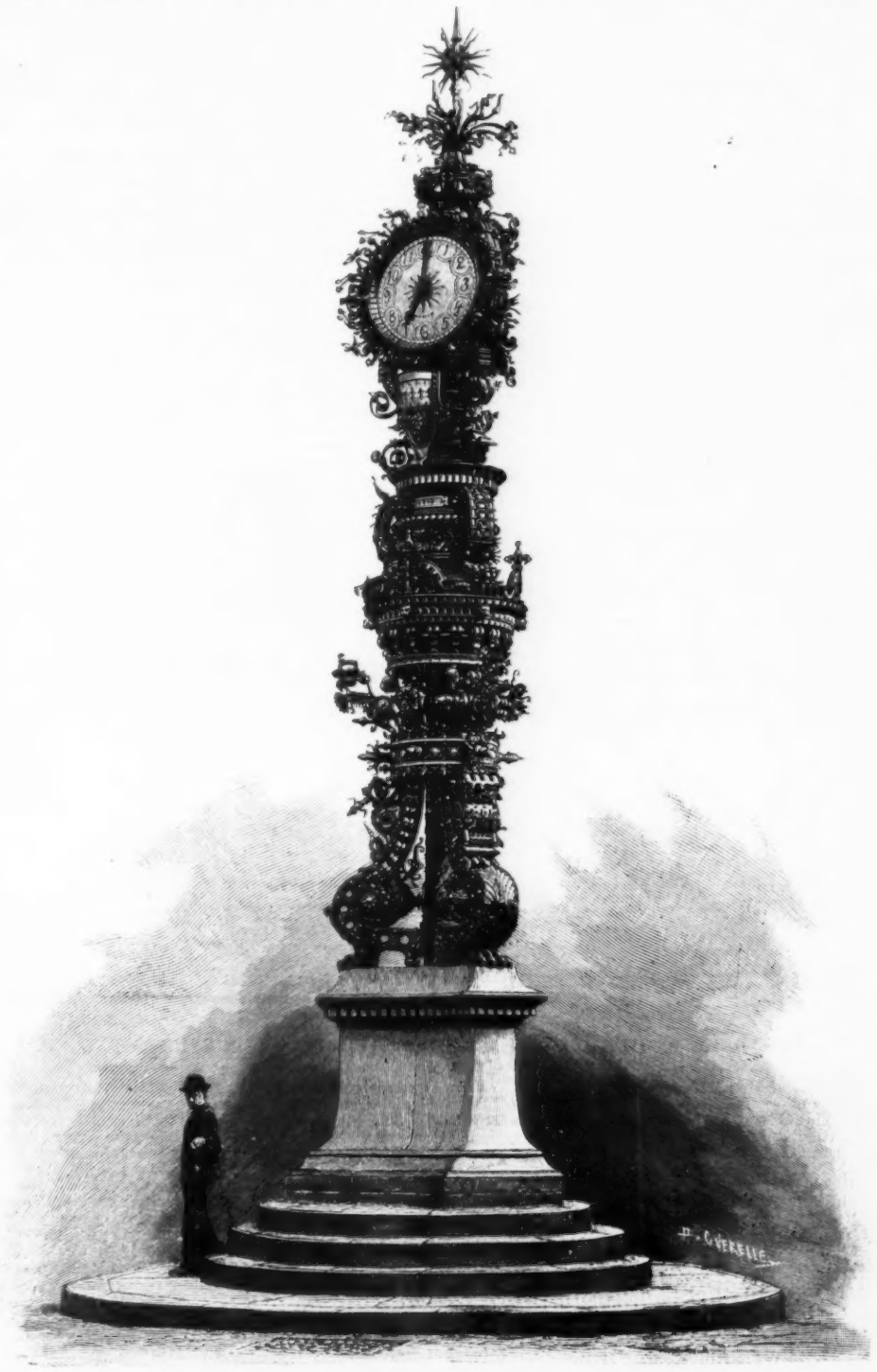
The gas mains that supply both the street lamps and the houses are of cast iron and asphalt. As Rue Reaumur is comprised in three of the sectors of electricity, it is likewise provided with electric circuits, which are of three types: one of two wires, one of three wires and one of five. We are indebted to Le Génie Civil for the above description and to La Nature for the illustrations.

CANADIAN RAILWAY BUILDING.

CANADA, the Canadian Magazine believes, is building railroads too fast. It states that at the date of the latest statistics there were 16,091 miles of track laid in the Dominion, to the construction of which the national government had contributed at the rate of $9,369 a mile, the provincial governments at the rate of $1,847, and the municipalities $881 a mile—a total, in round numbers, of $195,000,000. Results do not seem to warrant this great liberality. While in Cape Colony the proportion of net revenue to capital cost of railways is 5·75 per cent., in India 4·96 per cent., in South Australia 3·13 per cent., in New South Wales 3·46 per cent., in New Zealand 2·73 per cent., and in Queensland 2·13 per cent., in Canada the proportion is only 1·57 per cent. In Tasmania alone of all the British colonies is there a lower return. The cost of a railway, it has been said, should not be more than ten times its annual traffic—that is, the annual traffic should be 10 per cent. of its capital cost. Applied to Canadian railways, this requirement would indicate that their cost was far beyond the limit. In 1895 the gross receipts of the Canadian railroads amounted to only $46,785,487, while the paid-up capital was $894,660,559, the percentage of traffic to cost being about 5¼ instead of 10. This result is certainly disappointing; but it should be ascribed, we think, not to impolitic haste in opening the resources of the Dominion by liberal encouragement of railway enterprise, but to the poor success of the government in encouraging immigration, which may be remedied when the mineral wealth of Ontario and British Columbia has been proved in a convincing way.

THE CLOCK OF PLACE GAMBETTA, AMIENS.

THE clock of Place Gambetta at Amiens, illustrated herewith, is a beautiful work of art due to Mr. Ricquier, an architect, and Mr. Roze, a sculptor. From a Normandy granite base, having the form of a triangular prism with sloping sides, rises an openwork column of hammered iron, bronze and enamel, whence detaches itself a foliage of drooping palm leaves. At the top the ironwork spreads out in graceful curves that hold in their embrace the sphere of chased copper which contains the mechanism of the clock, and that wind about the three glass dials enameled with many colors. The whole is terminated by a beautiful piece of ironwork representing foliage and flowers.



CLOCK OF HAMMERED IRON UPON PLACE GAMBETTA, AMIENS.

The monument will be completed by the addition of an allegorical bronze piece upon which Mr. Roze is now at work.

For these details and the illustration we are indebted to Le Magasin Pittoresque.

The longest bridge in the world, according to the Zeitschrift für Transportwesen und Strassenbau, is a stone structure which, near the city of Sangang, in China, spans an inlet of the Yellow Sea. Its length as claimed is 8½ kiloms. (5¼ miles). The number of piers in the structure is 300; each of these is ornamented with a marble lion executed in three times life size. The top of the roadway is located 64 ft. above mean low water level. The bridge, as claimed, is about 800 years old, and its masonry is reported to be in an excellent state of preservation.

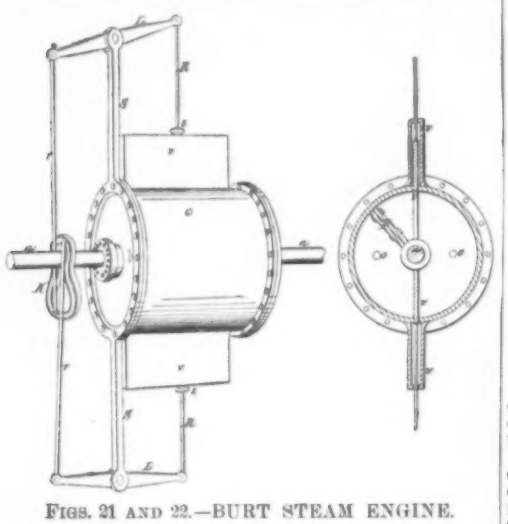
LINCOLN'S PRIVATE CAR.

A RELIC of much historic interest to Americans stands neglected and forgotten in a corner of the Union Pacific yard at Omaha, says the New York Times. It is the private car built for President Lincoln, in 1864, at the military car shops in Alexandria, Va., and it was often used by him while visiting the Army of the Potomac and in journeys to New York and Philadelphia. The car is forty-two feet long by eight and one-half feet wide, and it was divided into three compartments. It was entered by a door in the corner, which opened into a narrow passageway extending the entire length of the car along one side. From this passageway doors opened into each of the three private rooms. The room in one end of the car was considerably larger than the others, and was furnished with a large sofa and reclining chairs. The small rooms were also provided with sofa and chairs, although somewhat inferior to those in the large room. This larger compartment constituted President Lincoln's office and study, and is where he entertained his guests and transacted business with officials of the government and generals of the army. The sofa is a combination affair, and was made of unusual length, to accommodate the elongated form of the President. The car was ironclad, armor being set in between the inner and outer walls, rendering it bulletproof. This added considerably to its weight, so much so that its builders thought it necessary to mount it on four four-wheeled trucks. After Lincoln's death the car, with other railroad material owned by the government, was sold at auction and bought by Sidney Dillon. It was used for a while by the Union Pacific directors, but then was superseded by finer cars. Now its sides are cracked and weatherbeaten, and the glass in its windows and the brass railings on its platforms are long ago gone. All the compartments and sumptuous interior furnishings and decorations have been removed, and it stands like a barren, decaying hulk of its once proud self.

[Continued from SUPPLEMENT, No. 1110, page 17741.]

ROTARY PUMPS AND ENGINES: THEIR ORIGIN AND LATER DEVELOPMENT.

THE engine invented by Enoch Burt, an American, and patented in 1816, has a special interest as being one of the first instances of a rotary engine possessing a special gear external to the cylinder for operating the abutments and the steam valves. Figs. 21 and 22 are



FIGS. 21 AND 22.—BURT STEAM ENGINE.

reproduced from the original patent drawings, and show the mechanism for operating the abutments; the valve gear, however, is not shown nor are its details described in the patent. The main shaft passed through the axis of the cylinder, and carried a single piston, which consists of several plates packed to form a diaphragm and capable of adjustment to compensate for wear. Two sliding abutments, v, were arranged to work vertically in pockets which projected from the cylinder. The abutments were connected by means of rocking levers and rods with a cam, k, attached to the main shaft. The steam ports, o, were arranged at right angles with the abutments. Immediately upon the piston passing an abutment the latter began to close, and it was completely shut by the time the piston was at right angles with it and was passing the next steam port. At this moment steam was fed through this port between the piston and the abutment that had just closed, and the steam in front of the piston was condensed. Burt's engine is one of the earliest instances of a condensing rotary engine, and this fact, taken in connection with the gear for operating the abutments and the early date of the patent, renders this American patent one of great interest and merit.

The Adams pump or engine, Fig. 23, is also an American invention, the patent having been taken out

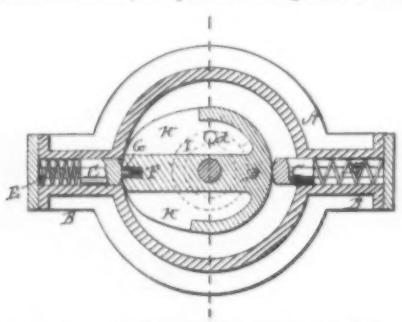


FIG. 23.—ADAMS ENGINE OR PUMP.

in 1875. The letter A represents a cylindrical casing, provided on opposite sides with chambers, B B, containing sliding abutments, C, which are pressed forward toward the piston, D, by means of the coiled spring, E. Said piston, D, is constructed in the form of an oval disk of suitable thickness, mounted eccentrically upon a shaft or journal, D', extending through packed boxes in the heads of the cylinder. The longer end or side of the piston revolves in contact with the interior of the cylinder, and is chambered on opposite sides of its periphery, leaving a partition, F, which is provided with a spring packing, G, at its edge. The chambers, H H', thus formed are entirely separate from each other when the piston is inserted in the casing, the valves, C C, preventing any communication as the piston revolves. One chamber communicates by means of an opening, d, through the side of the valve with an annular groove, I, in one head of the cylinder, and the other with a similar groove, K, in the opposite head, which lead respectively to the induction and eduction ports, L and M.

Fig. 24 is reproduced from the drawings accompanying the patent of C. T. Boardman, of New Jersey, dated June 9, 1863. The inventor was aiming to dispense, to a great extent, with the use of packing, and avoid the use of working joints composed of surfaces perpendicular to the axis of rotation. Attention was also given to the question of expansion. The steam chamber, A, was not, geometrically considered, a cylinder, but merely a segment of one, receiving within it as much of the piston wheel, B, as would embrace two of the pistons, C. This cylinder was formed with a steam channel, e, which was semicircular in cross section. Three pockets, b, were formed in the surface of the hub or piston wheel, B, this wheel being placed concentrically with the segmental cylinder, A, and each pocket contained a swing piston, C. A steam port, M, was formed at one end of the steam channel and an exhaust port, N, at the opposite end. The steam channel was closed by two abutments, G G', which were held in place by the clamps, H H'. The pistons, C, were operated by means of external bell crank levers attached to the ends of shafts, p, and cams attached to the casting, A, and were thrown out, as shown in the illustration, in contact with A immediately on entering the steam channel and withdrawn as soon as they passed the exhaust port, N. Cams were also attached to the piston wheel, by means of which the cut-off valve, P, was

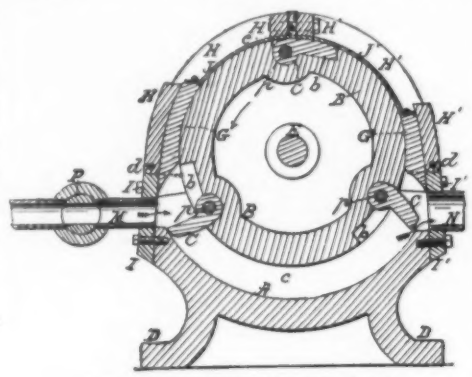


FIG. 24.—BOARDMAN ENGINE.

opened every time a piston passed abutment, G, and closed at a certain part of the stroke corresponding to the required expansion.

The Berrenberg engine, Fig. 25, also an American device, patented in 1886, introduces to the reader the class of rotary engines having rotary valves. Referring to the illustration, A, the casing, is formed of two intersecting cylinders—a larger one, A', for the steam piston and a smaller one, A^2, for the rotary valve, E. A gear wheel on the driving shaft, C, meshes with a gear wheel of the same size on the shaft, E', of the rotary valve, E, so that the same is rotated at the same speed as the hub, D. The hub, D, is provided with fixed pistons, D', at diametrically opposite points, which are provided with segmental wings, D^2, that are hinged at one end to the pistons. The wings, D^2, are beveled on their inner sides and at the ends opposite the wings' connection with the pistons, D', so as to facilitate the entering of the steam between the pistons and wings, and force the latter in an outward direction into tight contact with the interior surface of the main cylinder, A'. The pistons, D', and wings, D^2, project beyond the circumference of the hub, D, and fit into recesses, e e, at diametrically opposite points of the rotary valve, E, said recesses being connected by a diametrical channel, e'.

The live steam enters through an inlet port, f, of the valve chest, A^2, that is arranged at right angles to a horizontal plane passing through the axes of the shafts, C and E', and passes through the center channel, e', when one of the recesses, e, is moving across the inlet port, f. The live steam acts then on the piston, D', and hinged wing, D^2, and imparts rotary motion to the piston until the steam is shut off as the recess, e, has passed the inlet, f. In this position the steam works

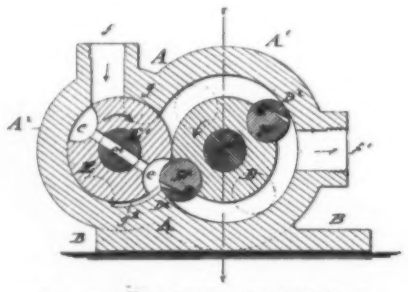


FIG. 25.—BERRENBERG ENGINE.

expansively on the wing, D^2, of the piston until said wing arrives at the exhaust port, f', of the casing, which exhaust port is located in line with the axes of the shafts, C E'. As soon as one abutment, D', of the piston has passed the exhaust port, the other is in a position to be acted upon again by the live steam, and so on, whereby continuous rotary motion is imparted to the piston, D, and driving shaft, C. The abutment is formed by the rolling contact of the two cylinders or hubs, D and E, and it is here that the problem of keeping a steamtight connection would be liable in the course of time to cause trouble. The nature of the contact would prohibit the use of the ordinary systems of packing adopted in rotary engines.

Fig. 26 represents a rotary condensing engine patented in America in 1844 by Matthew Fletcher. A hollow drum, C, which was placed eccentrically within the cylinder, A, contained three radial slides, S, rectangular in section, which served to guide sliding blocks, R, in which were pivoted the pistons, E, as shown in the illustration. The pistons were approximately T shaped in cross section, the top bar of the T being curved to the same radius as the cylinder, A, and sliding in steamtight contact with it. The sliding blocks, R, were caused to move in and out by means of circular rings attached to the cylinder, these rings being concentric with the cylinder. This arrangement caused the pistons to lie in true peripheral contact with the cylinder, the radial shank of the pistons always pointing to the cylinder center. Steam was led in through F to a steam chest, G, where it was controlled by a D valve operated by a screw and small hand crank. In the position shown in the illustration, the steam is admitted from G through K to a half round steam pipe, I, and passed into the cylinder through the ports, L. After driving the pistons through the upper part of the stroke, the steam exhausted at M into the exhaust pipe, N, and out through O and P to the condenser. In addition to being kept in contact with the cylinder by the rings above mentioned, the pistons are made steamtight by the pressure of the steam itself. The inventor thought that his device would show to best advantage if it were worked "first as a simple high pressure engine and the steam then transmitted to another or more machines of the same construction."

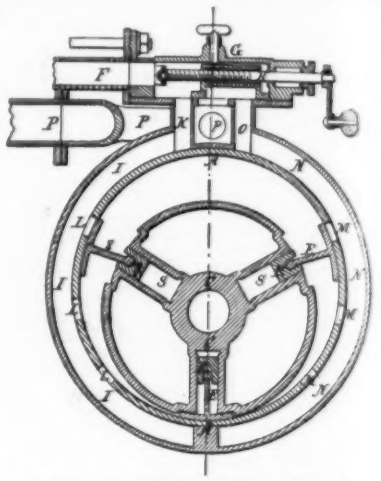


FIG. 26.—M. FLETCHER ENGINE.

The pump shown in Fig. 27 was constructed by Heppel, in Switzerland. It consists of a cylindrical chamber, a, in which are four plane rectangular pistons, d, which rotate about the axis of the cylinder. Each piston is attached by a link, c, to a pin, 3, near the periphery of the disk, b, which rotates eccentrically within the cylinder, a. Owing to the eccentricity of the disk, b, with reference to the cylinder, it is evident that the pistons will not have a uniform speed of rotation, but that they will travel slowly in passing across the center, 2, of the disk, and more rapidly in performing that part of their rotation which lies opposite to or furthest removed from 2; in other words, the area of the space between any two pistons will vary, as shown in Fig. 27. The area will be smallest just before any

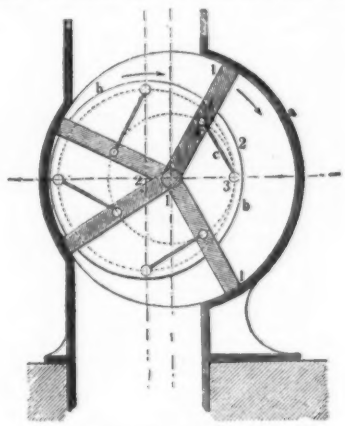


FIG. 27.—HEPPEL PUMP.

piston begins to pass the inlet, and it will begin to increase at that time. It will continue to enlarge until the next following piston has passed the inlet, and as soon as the first of the said pistons has opened into the delivery pipe the following piston will commence to overtake it, reducing the area between them and, as it were, squeezing the water out into the discharge pipe.

The same principle is used in the engine designed by Stocker in 1872, Fig. 28, in which the space between the pistons varies from almost nothing to a maximum.

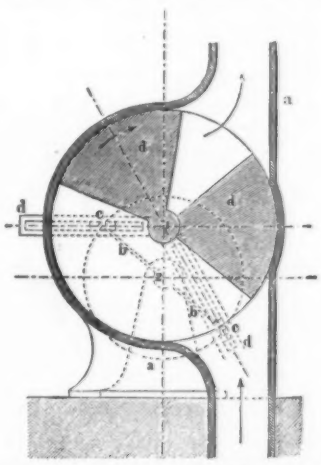


FIG. 28.—STOCKER STEAM ENGINE.

Each piston is connected with its own slide, d, placed outside the cylinder, and each sliding block, c, is connected by an arm, b, with a shaft, 2, which is placed eccentrically to the axis, 1, of the cylinder. The reduction of the space between the two sector shaped pistons, d, to nothing is accomplished by causing them to cover the proper angle. In the engine or pump shown in Fig. 29 George Smith made use of four pistons and placed the device for varying the angular velocity inside the steam cylinder. This consisted of a rotary disk, b, set eccentrically within the cylinder. Four

pins, 3, worked in slots cut in the shank of the pistons, the varying angular velocity being due, as before, to the eccentricity of the cylinder and disk.

Of all the curious combinations to which the quest of a successful rotary engine has given rise, the disk engine of Davies is perhaps the most remarkable. The first inventors are stated to have been the brothers

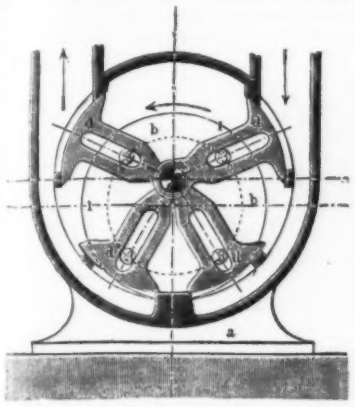
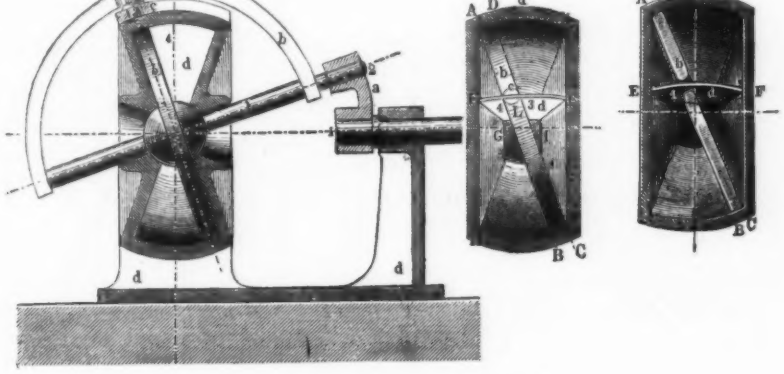


FIG. 29.—SMITH PUMP OR ENGINE.

Dakeyne (England), who patented the machine in 1830, for use as a pump or steam engine. One of these engines was used with improvements by Bishop in the Times printing office, London. The details of this engine, which is commonly known as the Davies disk engine, are shown in Figs. 30, 31, and 32. The main shaft, l, carried a crank, a, which was engaged by a shaft, b; this shaft having a double gyratory movement about the center of the cylinder, d. The shaft, b, carried by means of a semicircular brace a pin, 3, which engaged a block, e. The shaft, b, carried also a disk piston, b, which turned upon an axis at 90 degrees to the axis of the pin, 3. The piston consisted of a plane disk with spherical surfaces which worked in close



FIGS. 30, 31, 32.—DAVIES ENGINE.

contact with the steam chamber at its center and periphery. This chamber had the form of two circular cones, shown in Fig. 31, by A H G and C I K. The geometrical axis of pin, 3, moved always in one plane, and parallel to this plane a diaphragm, 4, with plane sides was fixed in the chamber, d. The block, e, consisted of two halves of a cylinder which worked in steam-tight contact with the diaphragm, 4, and the cylindrical edges of piston disk, b. The surfaces, A B and D C, of the piston touch the coned surfaces of the chamber as the engine turns. The diaphragm, E F, divides the space on each side of the piston into two parts, the volume of which changes from nothing to the full capacity as the engine rotates. The valves were worked by a separate gear, external to the cylinder, and the machine was used either as a steam engine or pump. Fig. 32 shows the substitution of a simple radial slot in piston, b, for the divided cylindrical block, C.

Fig. 33 shows a disk engine by Reuleaux (France)

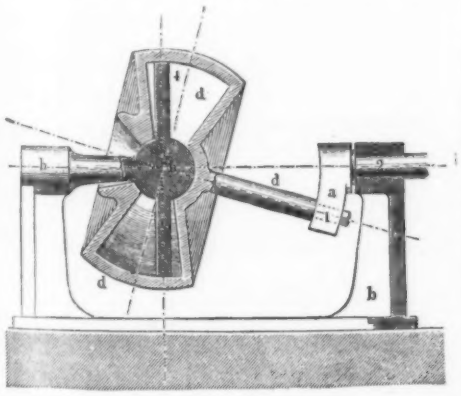
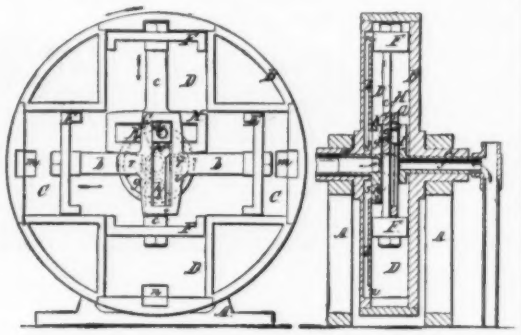


FIG. 33.—REULEAUX ENGINE OR PUMP.

which is simply a revision of the Davies engine. Here the part, b, is fixed and the chamber moves upon it, the shaft, d, being formed integrally with the chamber and serving to turn the crank, a.

The steam engine shown in Figs. 34 and 35 was patented in America in 1867 by Abraham Kipp. By reference to the figures it will be seen that A represents the frame of the engine, carrying a drum, B, hung by hollow necks or trunnions, a a, in the frame and rotating therein. This drum carries within it two double radial cylinders, C C and D D, arranged at right angles to each other, and open at their inner ends. Reciprocating within these cylinders are pistons, E E and F F, the one set of pistons, E E, being connected by rods, b b, and yoke, G, while the other pistons, F F, are similarly linked together by rods, c c, and yoke, H.



FIGS. 34 AND 35.—KIPP ENGINE.

The yokes, G and H, are made to gear by or through blocks, d d, with a wrist pin, e, of a stationary crank, I, fast to a steam pipe, J, passing axially through the one hollow trunnion of the drum, B, and in open communication with the interior of the space of the latter. The opposite hollow trunnion of the drum serves to form an outlet for the spent or exhaust steam.

Geared with the wrist pin, e, of the stationary crank is a stationary disk valve, K, occupying a concentric position to the drum, and bearing against its inner face, with which it is kept in close contact by the pressure of the steam within the drum acting upon the back of said valve. This valve has a steam passage or opening, g, of segmental form, made through it, the same being arranged on one side of two segmental blocks or face formations, h h, while an exhaust covered cavity, i, of say similar configuration to the open passage, g, is formed in the valve, on the opposite side of said blocks.

Arranged along or across the one side or face of the drum are radial passages, terminating at their outer ends in ports, m m and n n, in open communication with the cylinders, C C and D D, at the backs of the pistons, and at their inner ends in ports, r r and s s, under cover of the valve, K.

Steam being turned on, it fills in a constant manner the interior of the drum, between the inner faces of the pistons, E E and F F, acting in a negative manner, or with counteracting force, on said faces, and on the two sides of the drum; but, by the construction of the valve, K, and arrangement of the steam passages, with their ports, m m, n n, and r r, s s, steam is also being admitted through the opening, g, to act upon the backs of two of the pistons, E and F, while the other two of such pistons are open, by the passages and ports of their respective cylinders, to the exhaust cavity, i, of the valve. By this disposition of the parts, passages, and ports, and connection of the pistons with the wrist pin, e, of the stationary crank, I, as described, a rotary motion is communicated to the drum, the live steam being admitted to and the spent steam exhausted from the backs alternately, first of one pair of pistons, E F, and then the other pair in their order.

Another rotary engine with reciprocating pistons is shown in Fig. 36. It was invented by Charles G. Ruths in 1891, who described it as a "revolving cylinder engine."

A A A are the cylinders, of which there are preferably three or more. These cylinders are fixed so as to radiate from a central shaft, B, and this shaft is journaled horizontally, so as to rotate within its journal boxes. The outer ends of the cylinders may be open, and within the cylinders are fitted the pistons, C, having the piston rods, D, extending outwardly, and upon the outer ends of these piston rods are fixed the anti-frictional shoes or rollers, D'.

E is a ring fixed upon a base and surrounding the cylinders and shaft, so that the latter is eccentric to the interior periphery of the ring. The position of the shaft with reference to the ring is such that when either cylinder stands with its end downward below the shaft its piston will be forced into the inner end of the cylinder by reason of the contact of the anti-frictional shoe with the periphery of the ring at a point where said ring is nearest to the shaft upon which the cylinders are fixed. From this point the distance gradually increases until the cylinder is at the top or above the shaft, when its piston will have gradually moved out until it is at the outer end of its stroke, the shoe at the end of the piston rod remaining in contact with the interior periphery of the stationary eccentrically mounted ring.

It will be manifest from this construction that whenever steam is admitted into either of the cylinders after it has passed its lowest point, where it is nearest to the periphery of the ring, the pressure upon the piston,

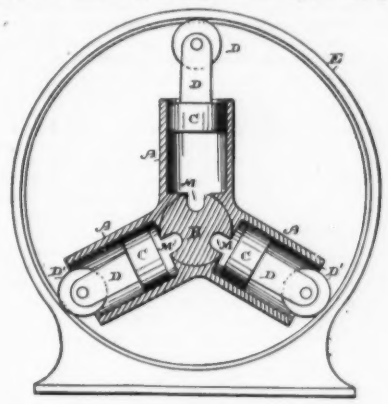


FIG. 36.—RUTHS ENGINE.

forcing it and the piston rod against the interior of the eccentric ring, will cause the shaft upon which the cylinder is mounted to rotate, the piston gradually moving outward until it has reached the opposite point, where the piston is at the greatest distance from the center. Several of these cylinders being mounted upon the same shaft, each one takes steam successively as it passes this nearest point, and thus the operation is continuous. Steam is admitted to the cylinders through the trunnions, and the ports are so arranged that two cylinders will be receiving steam at all times.

The engine designed by F. W. Link, an American, in 1890, presents another curious and novel attempt to produce a rotary engine. As described by the inventor, his object was to provide an improved valveless engine which should move continuously in one direction and transmit its motion by means of elliptic cog-wheels.

The engine was composed of a pair of curved cylinders, P P; a circular piston rod, L, to which were attached the two pistons, Q Q, the pistons traveling within the cylinders with a reciprocating rotary motion, and a pair of rocking radial arms, K K, which transmitted the motion of the piston rod to elliptical gears (not shown in the engraving), which "controlled the motion and transmitted the power of the engine."

The cylinders with the steam pipe, p, were carried by

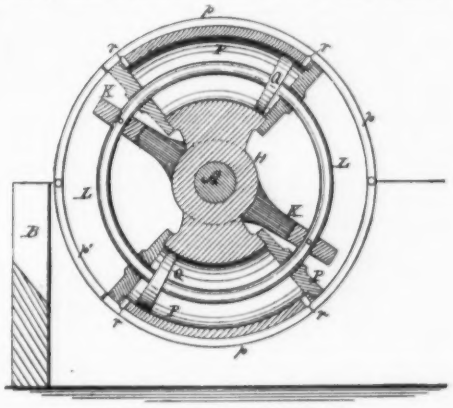


FIG. 37.—LINK ENGINE.

a bracket, H, which was keyed firmly to the main shaft, A, and rotated with it. The radial arms, K K, to which the piston rod, L, was keyed, were journaled loosely upon A, and carried an elliptical gear which meshed with another elliptical gear carried upon a countershaft. When steam was admitted to the cylinders through the ports, r, at either end of the cylinders, the difference in the diameters of the elliptical gears at the point of contact caused the main shaft elliptical gear with the attached parts to rotate. The engine was also built, if desired, with four instead of two cylinders.

The oscillating engine, Fig. 38, which was brought

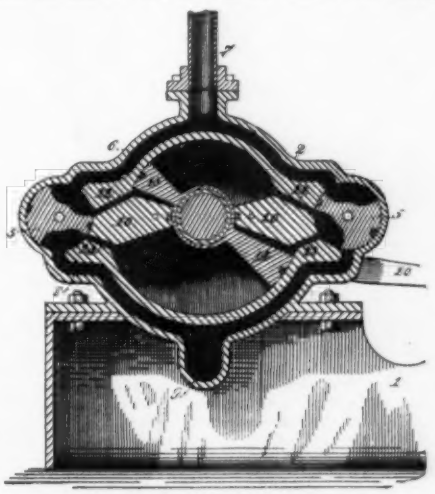


FIG. 38.—BATES ENGINE.

out by S. L. Bates, in 1889, is remarkable as being worked on the compound principle.

Referring to the engraving, 1 is the bed of the engine upon one end of which is mounted the cylinder, 2, and at the other end the crankshaft, 3, which is omitted from the figure shown. The cylinder is oblong in shape, the middle portion being partially circular, and the ends being extended to form seats or chests for the valves, 5. In the upper part of the shell forming the cylinder and steamchests is an induction port, 6, leading from the steam pipe, 7, to the steamchest. A similar eduction port, 8, leads from said steamchests to an exhaust outlet, 9.

In the middle part of the cylinder, between inwardly extending abutments, 10, is mounted the piston, 13, 14, which vibrates in a vertical plane. The central portion of the piston is circular in cross section, and carries two radial wings, 13, 14, of unequal length, to correspond with the radius of the cylinder against whose surface they travel in steamtight contact. The piston is carried on trunnions which carry on the outside of the cylinder suitable cranks from which connecting rods, 20, extend to a pair of cranks on the main shaft above mentioned. Between the induction and eduction ports above mentioned, shorter ports, 22 and 23, lead from the steamchests to the upper and lower compartments of the cylinder respectively. The rotary steam valves are operated by cranks and connecting rods controlled by an automatic governor.

The operation of the engine will now be clearly seen. In the illustration, the engine is represented as taking steam at the end farther from the belt wheel and in the upper portion of the cylinder. The valve at the other end has already opened to allow the exhaust steam to pass out and through the proper port into the lower portion of the cylinder, where it acts upon the longer wing of the piston. As the piston travels the valves move forward, until the inner wing of the one nearer the beltwheel is between the intermediate ports, 22 and 23, and the corresponding part of the other valve lies between the ports, 6 and 22. The opposite wing of this valve at the same time covers the eduction port, 8, as shown by the position of the valve at the other end of the cylinder. In other words, the relative positions of the valves are exactly reversed, the engine taking live steam in the upper part, exhaust steam in the lower part, and exhausting finally through the eduction port, 7, in the reverse order from that indicated in the engraving. This construction is such as to produce a compound engine in very compact form, and of such a nature as to effect economically a high development of power.

It is claimed very justly that if the piston passes through 145°, as in the case of this engine, the loss of power in passing the dead centers is comparatively small, since the leverage of the piston cranks increases greatly toward the termini of its stroke.

With the consideration of the Bates engine we close our review of the origin and development of rotary engines, or at least of those classes of such machines as utilize the steam in a closed chamber. We have endeavored in making our selection to show such combinations as represent the origin and organic development of the closed cylinder engine or pump. Enough has been shown and described to prove at once the ability and industry with which inventors have labored in, and apparently exhausted, the possibilities of this class of machine.

The drawings from which our engravings have been prepared have been taken from the records of the American and English Patent Offices, and from Reuleaux's Kinematics of Machinery.

PREHISTORIC TEXTILE ART OF THE EASTERN UNITED STATES.

In a recently published report of the Government Bureau of Ethnology, J. W. Powell director, to the Secretary of the Smithsonian Institution, the book being a handsome, richly illustrated quarto volume, appears a paper with the above title, by W. H. Holmes, from which we extract the following particulars and accompanying illustrations. It appears that considerable knowledge of fabrics of the ancient North American tribes is preserved in a way quite unique,

FABRIC MARKED VASE FROM MOUND IN NORTH CAROLINA.

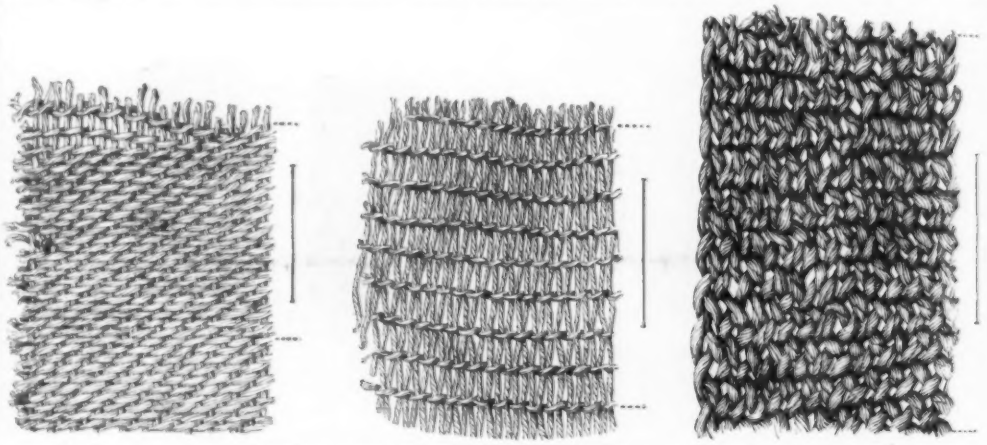
namely, the primitive potter employed woven textiles in the manufacture of earthenware, and during the process of construction the fabrics were impressed on the soft clay, so that when the vessels were baked the impressions became fixed. From these impressions castings have been taken in clay, wax or paper, whereby the fabrics are shown in relief, every feature coming out with great distinctness, so that it is possible to discover the nature of the threads employed, and detect the manner of their combination. It is noted that the pottery of the mound builders shows less evidence of the influence of textile forms than does that of most other nations.

In classifying the textile fabrics of the mound region, unbroken gradations are found from the rudest and heaviest textile constructions to the most delicate and refined textures. The broadest of these is based on the use of spun as opposed to unspun strands or parts. The term wattling is applied to work that is interlaced, plaited, etc., somewhat heavy, rigid, or slightly pliable parts, as rods, boughs, canes and vines. Primitive shelters and dwellings are often made in this manner, and rafts, cages, bridges, and fish weirs, and inclosures of various kinds. In basketry a wide range of products has been classified, including hampers, cradles, shields, etc., quivers, sieves, etc., it being believed that a close correspondence exists between the art of the present time and that which is represented by these prehistoric productions. Mats were not so varied in form or character, but mats of split cane, rushes and reeds were universally employed by the aborigines, and many remnants have been recovered from graves and caves. They were used for carpetings, mats, hangings, coverings and wrappings and were employed in house construction and for temporary or movable shelters. In weaving mats, where the strands or parts were uniform in size and rigidity they were simply interlaced, but when one strong and rigid series was to be kept in place by a pliable series, the latter were twisted about the former at the intersections as in ordinary twined weaving. The heavy series of strands or parts were held together side by side by the intertwined strands placed far apart, a common practice yet among mat makers.

The making of pliable fabrics, showing a considerable development of spinning and weaving, was an art which was considerably advanced on the arrival of the whites. Thread, cordage, and ropes of considerable weight were made with a surprising degree of uniformity and refinement. The finest threads were probably about the size of our No. 10 spool cotton. The materials employed for spinning were very diversified, the inner bark of the mulberry being a favorite material. Wild hemp, nettles, grains, and other like growths furnished much of the finer fibers, and the hackling was accomplished by pounding with hammers or sticks. The hair and sinews of animals were also frequently spun into threads and woven into cloth. The articles made were generally separate units of costumes, as mantles, shawls, cloaks, skirts, household hangings, nets for fishing, etc. The Cherokees are also said to have made very handsome carpets out of a wild hemp, and the manufacture of hempen garments by the Indians of the lower Mississippi is abundantly testified to in the accounts of the early Spanish explorers. Many specimens of these fabrics made by aboriginal workers have been discovered in caves and shelters in Kentucky and Tennessee, some interesting varieties of which are now preserved in the National Museum. Among these is the sandal or moccasin, neatly woven or plaited of bast, found in a Kentucky cave, shown in our illustration.

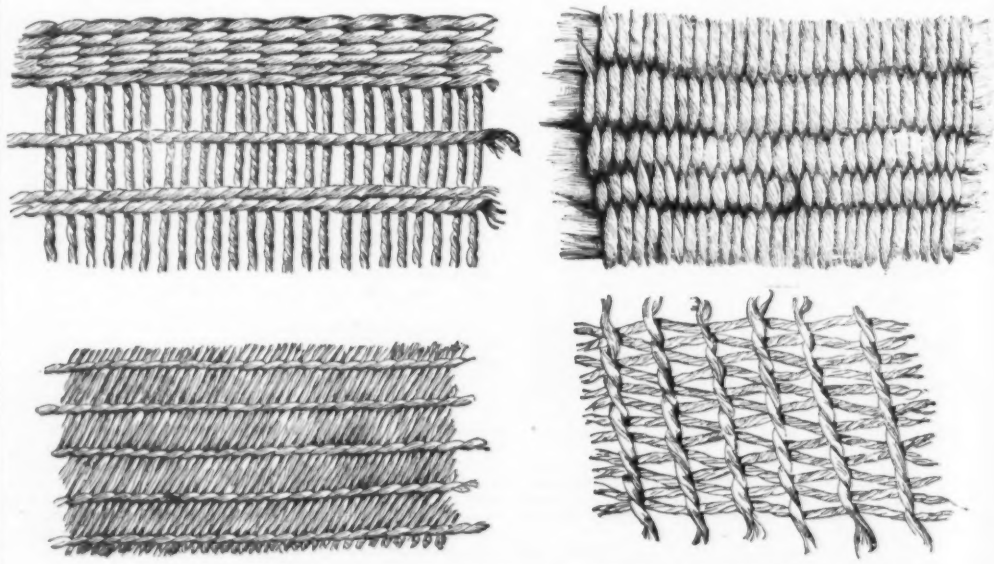
SANDAL FROM A KENTUCKY CAVE.

The textile work of the mound builders is demonstrated from hundreds of sources, and in one of our illustrations we give three specimens of these mound fabrics, which, since the articles were almost wholly burned with the dead, undoubtedly formed part of the clothing of the living, or were wrappings of articles deposited with the bodies. These coarse cloths may be considered as fairly representing the weaving of the mound builders. There are among them some finer examples of weaving than those obtained from the caves and shelters of Tennessee and Kentucky, but there is nothing specifically different in material or methods of combination, and nothing that suggests a higher stage of culture than that of the historic Indian.



CHARRED REMAINS OF FABRICS FROM MOUNDS.

Impressions of fabrics on pottery have been met with in great numbers, from the fact that it was a common practice among the aborigines to employ woven fabrics in the construction and ornamentation of earthenware. Fabric marked vases and shards are obtained from mounds, graves and village sites all over the country. Imprints of cloth woven in the plain, interlaced style appear to be quite rare, although it is difficult from the impressions on clay to distinguish this from other forms when the threads are closely impacted. In somewhat rare cases, as shown in the illustration of a vase from a mound in North Carolina, the interlacing is so arranged and alternated as to give diagonal effects which are peculiar to the interlaced fabrics, not being produced in twined or netted work. The impressions are not the result of a single application of the texture,



TWINED FABRICS FROM ANCIENT POTTERY, TENNESSEE.

but consist of several disconnected imprintings, as if the hand or a paddle covered with cloth had been used in handling the vessel or in imparting a desired finish to the surface. Twined weaving prevails in the fabrics impressed on pottery as in those from all other aboriginal sources. In one of the illustrations will be found characteristic examples of twined fabrics impressed on pottery, as found in various places in Tennessee, and the representation by means of clay casts gives a clear notion of the nature and appearance of fabric-marked pottery, all telling the same story of a simple, primitive culture, hardly advanced beyond the grade separating the savage from the barbarous condition.

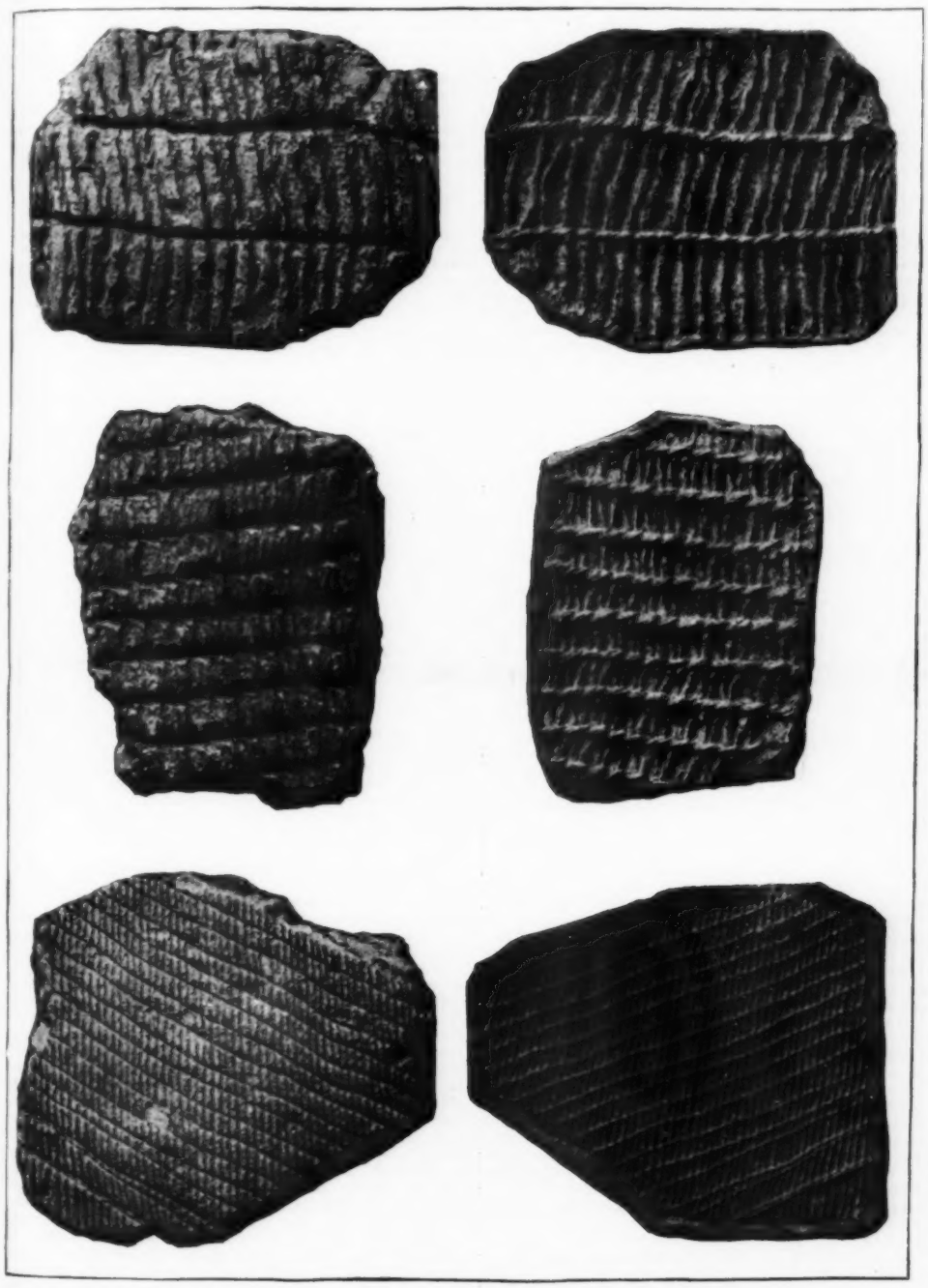
THE EXTRACTION OF GOLD BY CHEMICAL METHODS.

By T. K. ROSE, in *Nature*.

EXCLUDING mechanical, smelting, and amalgamation processes, the methods of extracting gold from its ores may conveniently be grouped together under the heading of wet or chemical methods. In these, the gold is dissolved by some suitable solvent, and is then separated from the unaltered ore by washing, and recovered by precipitation. The processes owe their origin to the rapid advance in the science of chemistry which has been made in the present century, and although they are now of vast importance, and give results which would astonish our grandfathers, it is, perhaps, somewhat surprising that chemistry has not done more for the gold mining industry. At the present day, the wet methods produce little more than a tenth of the total output of gold, while mechanical improvements in the old processes, made during the last half century, are probably answerable for four or five times as much.

Gold exists in nature practically only in one form, the metallic state, and the differences in treatment of the ores are necessitated by the variations in the physical condition of the metal, and by changes in the other constituents of the rock. Where the particles of gold are large enough to be seen by unassisted vision, they can usually be collected by means of mercury, and on the other hand, are not dissolved in a reasonable time by any of the solvents of gold yet applied in practice. In these cases, therefore, chemical methods are not advantageous. Nevertheless, it usually happens that some, if not all, of the gold in an ore is in an extremely fine state of division. It has recently been shown by Edman that a great proportion of the gold in American ores consists of particles less than $\frac{1}{1000}$ inch in diameter, and that some of these are less than $\frac{1}{12000}$ inch. Sometimes, gold in an ore is not visible even under the microscope, though readily detected by chemical means. Metal in such a condition is far more readily dissolved by a mobile liquid than by a viscous one like mercury, which does not wet the grains of sand between which the gold is hidden. Moreover, mercury may be prevented from doing its work by the presence of substances on which it exerts chemical action, such as the sulphides of antimony or arsenic, or which protect the gold from its action by coating the particles with insoluble films.

From such causes as these, it has long been recognized that the treatment of gold ores by mercury is very imperfect in a great many cases. The method is, speaking generally, unsatisfactory in extracting gold contained in pyrites or other sulphides, and it is in the treatment of these substances that the chlorination process, now nearly fifty years old, has its main value.



CLAY CASTS OF BITS OF FABRIC MARKED POTTERY.

Chlorine is a somewhat slow solvent for gold, but the time occupied by it in dissolving the fine flakes existing in pyrites is not excessive. Unfortunately, chlorine has a strongly preferential action on sulphides, and, to avoid the enormous waste of the gas which is entailed in the oxidation of a small percentage of these substances, it is necessary to precede chlorination by careful and complete roasting. Even in the rare cases, such as that of the Mount Morgan ore, in which the use of chlorine on completely oxidized ores is found to be desirable, the preliminary roasting is not omitted, as the percolation of liquids through the roasted mass is far easier than through the raw ore.

After roasting there is little difficulty in the process. Oxides of the metals, except the alkaline earths, are very slowly attacked by chlorine; and when the alkaline earths are present, salt is added in the roasting furnace. Here one of the sources of loss in the process is encountered, chloride of gold being formed and volatilized at all temperatures above 200°, when common salt is mixed with the ore. In long bedded furnaces, however, this loss is reduced to a minimum; chloride of gold is prevented from formation by the presence of large quantities of unoxidized pyrites, and when formed in the oxidized product in the hottest part of the furnace, it is in great part decomposed and reabsorbed during its passage over the bed of comparatively cool ore, which has just been charged into the furnace.

It was formerly the universal practice to apply the chlorine to the slightly damped roasted ore, in the form of gas, and this method has never been entirely abandoned. Subsequently, after Dr. Mears had discovered that compressed chlorine was more rapid in its action than the same agent under ordinary atmospheric pressure, strong aqueous solutions were used, the ore being agitated with the solvent in revolving barrels. This practice is still adhered to in several works in the United States. Elsewhere, however, it has been completely set aside. For example, at Mount Morgan, in Queensland, the largest chlorination mill in the world, stationary vats have been reverted to, aqueous solutions of chlorine being, however, still used. At this mill about 1,500 tons of ore are treated every week at a cost of about 18 shillings per ton, or little more than one-sixth of the value of the yield in gold.

After the ore has been treated with chlorine for a period varying in different mills from an hour to one or two days, the liquid is filtered off and the gold precipitated by ferrous sulphate, sulphureted hydrogen, or charcoal. As regards the relative advantages of these methods, it may be noted that charcoal only acts well with boiling solutions, and that sulphureted hydrogen is now recommended by its advocates even when copper is present in the ore, Rothwell having recently pointed out that in acid solutions there is partial precipitation, all the gold being removed from solution before the copper begins to come down.

The chlorination process, though perhaps unrivaled in the percentage of extraction which can usually be attained, labors under two serious disadvantages. Roasting the ore is often so expensive as to be impracticable, and the silver is, in any case, all lost. Both of these disadvantages are avoided by the use of the cyanide process. This was introduced by MacArthur and the Forrests after prolonged researches, having for their object the discovery of some chemical process which would not require a preliminary roasting of the ore.

The action of cyanide solutions on the precious metals had long been known. Elsner had stated, in 1846, that the presence of air was necessary for the dissolution of gold or silver by potassium cyanide, and subsequently, it was suggested that the action was represented by the equation

$$4Au + 8KCy + O_2 + 2H_2O = 4\,KAuCy_2 + 4KHO.$$

This equation has recently been established by Maclaurin (*Jour. Chem. Soc.*, vol. lxiii (1893), p. 724; vol. lxvii (1895), p. 199), who also showed that the dissolution of gold and silver becomes slower in proportion as free oxygen is more and more carefully excluded from the system. Thus, when a plate of gold was treated with a solution containing 1 per cent. of cyanide of potassium in a stoppered bottle filled with oxygen, the loss of weight was 0·24 gramme in 96 hours; in a shallow vessel exposed to the air, the loss was 0·00835 gramme in 24 hours, and in a flask, freed from air as completely as possible, the loss was only 0·0002 gramme in the same time. In addition, Maclaurin prepared the curves of solubility of gold and silver in cyanide solutions, and showed that the maximum rate of dissolution of both metals is reached at 0·25 per cent. of KCy, and diminishes slowly as the concentration is increased, and rapidly if it is decreased.

These results are in perfect accord with the experience gained in practice on a large scale. Before Maclaurin's papers were published, the favorite stock solution in South Africa had for some time been one containing from 0·25 to 0·30 per cent. of cyanide, although weaker solutions are also used with excellent effect. Moreover, the difficulties introduced by a lack of free oxygen in the ore have long been severely felt. In particular, when concentrates containing much pyrites are treated, the absorption of oxygen by the sulphides is so rapid that the dissolution of gold is soon checked and becomes extremely slow. Thus, while gold leaf floating on cyanide solutions is dissolved in a few minutes, and, if submerged, in a few hours, the films of gold in pyrites, which are probably similar in thickness to gold leaf, often take two or three weeks in going into solution.

This is so far from satisfactory that many efforts have been made to increase the speed of action of cyanide in some way. An artificial supply of oxygen, or air forced through the charge of ore and solution, was found to shorten the time required but to increase the waste of cyanide, and similar results follow from the use of various oxidizing agents, such as manganese dioxide, hydrogen peroxide, and bleaching powder.

Greater interest attaches to the proposal made by Sulman and Teed to add bromide of cyanogen to ordinary cyanide solutions (*Trans. of the Inst. of Mining and Metallurgy*, vol. iii (1895), p. 202). They put forward the equation

$$CyBr + 3KCy + 2Au = 2KAuCy_2 + KBr$$

as expressing the action which takes place, but no direct proof has yet been afforded of the validity of this equation. These experimenters are, however, convinced that oxygen plays no part in the action, and, consequently, that except for the fact that the edges only of the films of gold in pyrites are presented for attack, solution of the gold in concentrates is as rapid as that in quartzose ores. This view is borne out by a number of trials on half ton lots of ore, although no results of actual working have yet been published. Even when there is full access of air, however, as in the case of gold leaf floating on the solution, the addition of cyanogen bromide greatly increases the rate of action of potassium cyanide, and if air and bromide are together passed through a solution of cyanide, the rate is increased about 100 times.

Slowness of action in dissolving gold is of more importance than may at first sight appear, for it must be remembered that alkaline cyanides attack many of the constituents of gold ores at varying rates, and, therefore, that the longer the solution is left in contact with the ore, the greater will be the decomposition of the cyanide, and, consequently, the greater the total cost of the process. Decomposing pyrites (especially if sulphide of copper is present) are, when not in perfect contact with gold, particularly active in destroying cyanide, and, in order to partially prevent their effect,

it is customary to neutralize ores which have been rendered acid by the formation of sulphates by "weathering." The neutralization is effected by the addition of a solution of caustic soda or, more usually, of lime to the ore before it is treated with cyanide. The destruction of cyanide, however, still goes on to a limited extent in such cases, and treatment is rendered practicable only by the preferential or more rapid action of very dilute solutions of cyanide on gold as compared with their action on the sulphides.

The relative rates of action of cyanogen bromide on gold, and on the various sulphides and oxides met with in ores, remain undetermined, or at any rate unpublished, and until more light is thrown on these, either by laboratory experiments or by practical work on a large scale, it is impossible to judge what may be the future of the process. From some experiments, already made, it would appear that cyanogen bromide suffers considerable decomposition when placed in contact with some of the minerals met with in gold ores, and so it may happen that in many cases the haloid compound will be destroyed before it has time to get fairly to work in dissolving the gold.

The gold is recovered from solution either by its precipitation and replacement in solution by a metal positive to it in cyanide solutions, or by electro-deposition. The only metal largely used in practice is zinc, the action being one of direct replacement, expressed by the equation

$$2KAuCy_2 + Zn = 2Au + K_2ZnCy_4.$$

It has been found necessary to use the zinc in a fine state of division, and the filaments, prepared by turning zinc in a lathe, are certainly more efficient than other forms. The shavings are no more than 0·1 mm. in thickness, and 0·5 mm. in width. When packed in spongy form they weigh about six or seven lb. per cubic foot and can be ignited by a lucifer match, burning readily to zinc oxide. They must be freshly turned, as in practice the cyanide solutions are too dilute to clean dirty surfaces by dissolving hydrates or carbonates of zinc.

The action of the zinc is undoubtedly aided by the presence of lead, which exists as an impurity in commercial zinc to the extent of about 1 per cent., and by the iron gratings on which the filaments rest. Galvanic couples are thus formed, which assist in starting the action. Nevertheless, precipitation of the gold is at first slow, especially in very dilute solutions, and it is only after some gold has been thrown down, and the gold zinc couple formed, that the action becomes fairly vigorous. When the amount of gold in solution has fallen to about 0·0003 per cent., or from 1½ to 2 dwts. per ton of liquid, the action again becomes slow, and this amount is left unprecipitated in practice, but, as the solutions are used again on fresh charges of ore, no loss of gold occurs.

The black slimy deposit of gold or alloy of gold and zinc thus formed is washed and sieved off from the undecomposed zinc as far as possible, and is dried, roasted, and melted down with borax, carbonate of soda, and other fluxes, with or without a previous treatment with dilute sulphuric acid. The bullion thus obtained is very base, containing about 700 of gold per 1,000, and variable quantities of zinc, lead, copper, and other metals. It is subject to the disadvantage that assay pieces, taken in the ordinary way, frequently differ in composition from the ingot taken as a whole.

The recovery of the gold from cyanide solutions by electro-deposition is the basis of the Siemens-Halske process. In this process the cathodes are of iron, and the anodes of lead foil. A very large surface is given to the electrodes, 12,000 square feet of surface of lead being exposed in the treatment of 70 tons of solution per day at the Worcester Mine in the Transvaal. At stated intervals, the lead anodes, containing from 2 to 12 per cent. of gold, are removed, melted down and cupeled. The bullion produced is very fine, but the cost of precipitation appears to be greater than that by the zinc process, the main items being the lead and iron consumed. The current needed is only about 0·06 ampere per square foot, the power required being about 5 horse power in the treatment of 70 tons of solution per day. The process makes but slow progress, only a small proportion of the gold produced by cyanide on the Rand being obtained in this way.

FORMALDEHYDE AS A DISINFECTANT.

DR. E. H. WILSON, chief of the bureau of bacteriology of the Brooklyn Health Department, has been experimenting for several months with formaldehyde gas as a disinfectant for diphtheria and other contagious or infectious diseases, says the New York Tribune. Formaldehyde has been occupying the attention of the scientific world to a considerable extent. In Germany especially careful experiments have been making to ascertain what disease bacteria it will kill and how easily it will kill them. Most of the reports from the German chemists and bacteriologists are to the effect that nothing that has life can withstand the fearfully deadly fumes of this compound, and that it is doing wonders as a disinfectant. One or two reports have been a little less sanguine as to its power to destroy all disease germs.

Practical experiments have been made with formaldehyde in Paris, and the health departments of two American cities, Washington and Brooklyn, have had it under consideration for some time.

Dr. Wilson has run across some difficulties in his experiments, which are believed to be rather matters of production and application of the gas than a failure to kill bacteria.

Dr. Wilson says: "I think formaldehyde is far more reliable as a disinfectant than is sulphur. But I do not think it is as thorough as steam. Heat is the best known disinfectant, and heat is applied through steam for disinfecting."

Formaldehyde is a combination of carbon, oxygen and hydrogen. It results from the oxidation of wood alcohol, the cheapest known form of alcohol. The German process is to burn an alcohol lamp beneath a cone-shaped platinum gauze.

Some time ago dry sulphur fumes were used for disinfecting in cases of diphtheria and kindred diseases. But it has been found that dry sulphur fumes are of little value. Dr. Emery, soon after taking office, added steam to the sulphur fumes and found the result to be much better for two reasons. The steam softened dry substances such as mucus, in which the germs may have become embedded, and the sulphur and steam mixed formed sulphuric acid, which is a much more active agent against bacteria than dry sulphur.

Later, Dr. Emery introduced the bread rubbing, bichloride and steam method of disinfection, which is the most effective and likewise the most expensive. The walls of the infected chamber were rubbed with dry bread, so as to get germs that may have lodged in the wall or ceiling to the floor. Bread was used because it did not injure the wall paper. Finally the floor was thoroughly washed with bichloride, in contact with which bacteria are certain to be killed. Carpets, bedding and other infected articles were taken to the disinfecting station and steamed.

So far as the experiments go, it seems that formaldehyde lies between the sulphur steam and the bread bichloride systems, both as to expense and effectiveness. It is more effective than sulphur and steam and a little more expensive, but neither so effective nor expensive as bichloride.

SHORTNESS OF BREATH ON HIGH MOUNTAINS.

SOME interesting experiments performed in the Italian Alps by Ugolino Mosso, on the respiration of man at great elevations, were described by him in a recent paper presented before the Royal Academy of the Lincei. The paper is abstracted in Cosmos (Paris, June 27), and we translate below the greater part of this abstract. Signor Mosso has shown that there is not so much difference as is generally supposed between the breathing at small and great elevations, especially when the subject is at rest. Mosso's experiments were carried out at various altitudes from 900 feet to 15,000 feet elevation. Says the article in question, which is translated by the Literary Digest:

"Precautions were taken that the fatigue of the climbers should not vitiate the results, and the measurement of the carbonic acid [exhaled] was made by means of a portable apparatus invented by the same savant [M. Mosso]. The subjects were three soldiers of the Alpine regiment, who were consequently habituated to the mountains and who would probably suffer little from a sojourn at heights exceeding 3,000 meters [9,840 feet].

"At Turin [905 feet above sea level] the three soldiers eliminated, in the air expired during a half hour, respectively 16, 12·6 and 12·5 gm. of carbon dioxide [247, 194 and 193 grains]. The figures are evidently variable and in proportion to the quantity of air inspired, and we find accordingly that the air inspired per half hour by these three soldiers was 270, 205 and 200 liters [9·5, 7·2 and 7 cubic feet]. This, then, is our point of departure.

"Having arrived at Queen Marguerite Cabin [9,994 feet], although the air was already rarefied by one-third, no one complained of mountain sickness. No alteration of respiration was produced till the party reached Gnifetti Cabin [10,873 feet]. The director of the expedition proved the periodicity of his own respiration during sleep; the soldiers, being more hardy, did not experience this phenomenon. But on the morrow, the expedition having arrived at its destination [15,088 feet], the influence of height produced its effect, and all were ill.

"'The periodic respiration was so marked in me,' says M. Mosso, 'that I could not sleep long at night, the deep inspirations that I was forced to make from time to time waking me up. The Alpine soldiers resisted better and showed no periodic respiration except at night.'

"At this height the volume of air inspired during a half hour and the quantity of carbonic acid expired were as follows: The first [soldier] with 276 liters [9·7 cubic feet] of air, had 15 gm. [232 grains] of carbonic acid; the second, 192 liters [6·7 cubic feet] and 11 gm. [169·7 grains] of carbonic acid; the third, 267 liters [9·3 cubic feet] and 15·5 gm. [239 grains] of carbonic acid.

"If we group the results obtained at the different stations, by putting in one column the volume of air inspired in a half hour, in another the quantity of carbonic acid expired, and in a third the ratio of these two volumes, we find that the height has no influence on the expulsion of carbonic acid, and that the ratio obtained at Turin remains nearly constant, whatever may be the height of the station (at least, up to the Marguerite Cabin). Moreover, and consequently, it follows that the volume of air inspired during a given period of time, at no matter which of these stations, presents no notable differences. The soldier who inspired 270 liters at Turin in a half hour inspired only 276 at 4,560 meters elevation. It must always be noted that the constancy of respiration shows itself only in the state of repose, and that if the individual sets to work or even moves about he at once feels the need of quickening his respiratory movements.

"Having arrived at Turin, M. Mosso wished to carry his experiment out further by placing himself in the pneumatic chamber of the Physiological Institute and causing the pressure to diminish progressively. Having reached the degree of rarefaction corresponding to a height of 6,405 meters [21,008 feet], he was able to prove that the quantity of carbonic acid eliminated was almost exactly identical with that eliminated before the experiment, only the frequency of the respiratory movements was augmented. He wished to extend his observations still further, and caused the air to be rarefied down to 30 cm. of mercury, corresponding to 7,402 meters [24,278 feet]. The experiment began to reach its limit at the expiration of twelve minutes, M. Mosso not being able any longer to give the necessary attention, and suffering from want of breath. He began the experiment a second time, but at the end of eleven minutes he could not continue, without being able to remember just why he could not. He only perceived that his intelligence and his memory were lessened and that the nervous and muscular system no longer functioned as in the normal state, as shown by the irregular handwriting of the notes that he took during the experiment.

"From data gathered during these two incomplete series of observations, it follows that at the pressure of 30 cm. of mercury a great diminution in the elimination of carbonic acid took place and an increase of the air inspired; but it is not useless to remark that these results are far from being sure, seeing the conditions under which they have been obtained.

"Finally, the conclusions of the author are the following: From the experiments just described, we must conclude that man breathes on mountains up to the height of 6,400 meters [21,000 feet] a volume of air almost equal to that which he respires at the sea level. The rarefaction of the air produces a diminution of the quantity of oxygen, but this quantity at the pressure of 34 cm. is yet sufficient for the needs of the blood, and it is not necessary to breathe more actively. Finally, the quantity of carbonic acid eliminated at the height of 6,400 meters is only slightly different from that eliminated at the altitude of Turin, or 276 meters above sea level."

DR. KOCH'S REPORTS ON RINDERPEST.

THREE reports have now been published by Dr. Koch on Rinderpest. The Cape of Good Hope Agricultural Journal for January 14 reprints the first two, while the third has appeared in the weekly edition of the Cape Times of February 10. The first is dated December 9, four days after Dr. Koch arrived at Kimberley, and the second and third, January 3 and 31 respectively. All hail from Kimberley, which city Dr. Koch has made his headquarters for the present. The scientific experiment station, which has been arranged and fitted up for him, is situated about two miles out. Dr. Edington's research station is at Taungs, where it is stated that the inhabitants have lost as many as 20,000 head of cattle from the pest. It will be remembered that Dr. Edington has discovered and cultivated certain micro-organisms which he believes to be the virus of cattle plague, and Dr. Koch is carrying out some experiments with cultures, placed at his disposal by Dr. Edington, to ascertain what, if any, part is played by them in the disease.

Elaborate precautions have had to be taken at the Victorian Compound, Dr. Koch's station, to avoid accidental infection of the animals under observation, which would entirely vitiate the inquiry. Dr. Koch provided himself with blood and other materials obtained from plague stricken animals, and with these he has already carried out a large number of inoculation experiments. In the first instance an efficient method had to be discovered of infecting animals artificially with the disease, for the methods hitherto employed were not attended with the desired success. Koch, instead of using the secretions of infected animals, has employed hypodermic injections of blood taken from rinderpest victims, and this method has proved extremely successful. All efforts so far to find, whether by cultivation or microscopical examination, a specific micro-organism in the blood have proved fruitless; neither has any specific microbe been discovered among those abundantly present in the mucus from the nose, the secretions, and other mucous membranes.

Dr. Koch has no intention of abandoning the search, but at present his efforts are concentrated upon finding a process which may attenuate the virus of rinderpest, so as to transform it into an antidote. The first steps in this direction were made by inoculating animals, such as sheep and goats, less susceptible to the disease than other cattle, with rinderpest blood. The symptoms consequent upon these inoculations resembled those of a migrated attack of rinderpest; the blood of these animals inoculated into other sheep and goats also induced symptoms of mild rinderpest, and the hope was raised that, after these inoculations had been continued through further generations, the blood of these animals might induce a modified attack of the disease in cattle. This hope proved, however, illusory, for cattle succumbed rapidly to rinderpest after such inoculations. Dr. Koch has also been endeavoring to produce an attenuated virus by chemical and physical means.

Rinderpest blood mixed with glycerine appears to suffer some abatement of its virulence, while even better results followed the addition of phenol to the virus. Cows inoculated with rinderpest blood and phenol did not contract the disease; moreover, when subsequently inoculated with virulent blood, they remained healthy. These experiments are being continued. A most noteworthy experiment was, however, the desiccation of rinderpest blood at a temperature of 31° C. during a period of four days. A head of cattle inoculated with this blood dissolved in water remained perfectly healthy. Unfortunately, however, although the inoculation produced no effect upon the animal, it also afforded it no protection from subsequent infection with fresh rinderpest blood. Of all the animals which have been infected with rinderpest blood at the experimental station, only four have recovered, and Dr. Koch has used them for ascertaining whether the blood of immune animals, for they did not contract the disease when reinoculated, possesses any protective power. The results were encouraging, for this blood certainly did exert a distinct immunizing action; but it remains to be seen how long this immunity lasts in animals thus vaccinated against rinderpest. It has been ascertained that neither birds, such as fowls, doves, pigeons, guinea fowls, and cranes are susceptible to the pest. An eagle and a secretary bird were fed for weeks on intestines taken from rinderpest animals, but absolutely no ill effect followed. Dogs and donkeys are also immune, as are likewise mice, guinea pigs, and rabbits; to pigs, only, so far, does it appear possible to transmit the infection. In conclusion, Dr. Koch's investigations with Dr. Edington's plague microbe have proved that the latter is not the cause of rinderpest. We are indebted to Nature for the above particulars.

THE following statistics relating to Italy are taken from official returns. Italy covers 286,589 square kilometers and contains 31,102,833 persons. The excessive growth of the population, which is given at 1 per cent. per annum, or about the same as England, is checked by emigration. Those who leave Italy with the intention of returning number 100,000 or 120,000 per annum. Those who leave definitely rose from 20,000 in 1876 to 170,000 in 1895. Argentina, Brazil, and the United States are the three principal countries the Italians seek. The annual mortality in Italy fell in 1895 to 25 per 1,000 from over 30 in previous years. The improvement is specially marked among infants. The food of the peasant and working classes is unsatisfactory. The peasants scarcely ever taste meat or procure wine. Suicide is less common than in other European countries, but it is on the increase.

ENGINEERING NOTES.

Only 66 kilometers (a little over 41 miles) of the German railways have four tracks, while the length of three-track railway lines amounts to even less, 40 kilometers (25 miles). About 34 per cent. of the railway mileage is double track. About 85 per cent. of the tunnels have double tracks.—Uhland's Wochenschrift.

According to a contemporary, the express company which operates over the Pittsburg and Lake Erie Railroad has placed on the Big Four and other roads a number of armored express cars, supposed to be burglar proof. They were built to withstand any attack that might be made upon them. A bullet proof room is located in the center of the car. These rooms are built of steel 1½ in. in thickness. The steel doors leading to either end of the car each have a small peephole through which a gun can be ranged and fired. On either side is a steel projection or turret a foot wide, extending from the level of the window sill to the roof.

From a report of the British consul at Florence we learn that about the middle of 1896 a successful trial was made at Verona of a new steam train, running on common roads, consisting of a locomotive, furnished with a steel Field boiler of 16 horse power, the motive force being transmitted through chains in accordance with Galle's system, of the weight when fully laden of 400 kilos. and when unloaded of 150 kilos., and of a carriage for the conveyance of about forty passengers. The train can be driven at a speed of from 15 to 20 kilos. per hour, run on gradients of 8 per 100, and on minimum curves of a radius of 3 meters at half and full speed. Will stop in a space of 2 meters. The consumption of the fuel is 3 kilos. per 1 kilom. The train was bought by the Italian Society for Motor Cars System Scott, at Verona.

A new and powerful machine is about to be added to the testing and experimental plant of the Massachusetts Institute of Technology. It is a much more powerful machine than has ever before been set up in this country. It will exert a pressure of 500,000 pounds, and can be used in testing a complete arch. The experiments to be made with it are expected to prove of great practical value, as it will measure accurately the thrust of an arch as well as the amount of down pressure which it will stand without breaking. The data to be obtained by its use is expected to be very valuable in building construction, and a knowledge of the exact stress in the thrust of the arch will aid materially in calculation of the needed strength in masonry. No such tests of whole arches have heretofore been made in this country, and what has been done elsewhere has been of little value. The machine was devised in the machine shop of the institute.

We have several times mentioned respirators designed for the benefit of those who have to work in a dusty atmosphere. The Génie Civil again directs attention to this subject, to which the French Northern Railway Company are said to pay due regard. In 1895, we are informed, a man occupied in the mill in which the painting materials are mixed and ground was supplied with one of the Détourbe respirators, which we described last year. The man had for thirty-three years been in the employ of the company, and had every year been on the sick list for about a month. Since wearing the respirator he has not been obliged to absent himself, and the company thus get the full benefit of his time, while formerly they had to pay him for a month in which he could not do any work. It looks rather hasty to draw any conclusion from the circumstance of this man's having worked for a year and a half without taking his customary rest in the hospital. But Ch. Briloque asserts that this example is by no means isolated, and that the health of the employes has notably improved since the introduction of suitable respirators.

Nothing has been done during the past twelve months in the way of railway construction in Bosnia and the Herzegovina, says The Engineer. The line Lasva-Travnik-Bugojno, destined, when carried on to Arzano and through Dalmatia, to put these provinces in direct communication with the port of Spalato, on the Adriatic, has not been proceeded with, and there seems no probability of anything being done during the ensuing year. The importance of this line being completed is brought home more forcibly by the late silting up of the mouth of the river Narenta, which prevents all but the very smallest steamers from reaching the port of Metkovic. The railway traffic receipts do not seem to have been so good in 1896 as in the previous year. For instance, the "Bosnisch-Herzegovinische-Staatsbahnen," during the nine months ended September 30 last, carried only 682,697 passengers and 379,080 tons of goods, against 685,829 passengers and 597,960 tons of goods during the corresponding period of 1895. On the other hand, the military line, Banjaluka-Doberlin, carried during the same period 111,259 passengers and 43,763 tons of goods against 105,956 passengers and 43,457 tons of goods in 1895.

A writer in one of the London architectural papers presents some interesting remarks relative to methods by which salt may be detected in sand. He says that if the sand is not contaminated with decaying organic matter, the easiest way is undoubtedly to put a few grains in the mouth, or to taste the water in which some of the sand has been stirred. If this test is objected to, put some of the sand in a wine glass, cover with distilled water, and, after agitating for some time, dip a piece of clean platinum wire into the water, and hold it in a colorless Bunsen gas flame. A persistent deep yellow color imparted to the flame will indicate the presence of sodium. The platinum should first be heated to burn off impurities; another method is to filter off the water from the sand by means of blotting paper, and to the liquid add a drop of silver nitrate solution. A curdy white precipitate will at once betray the presence of common salt. In ascertaining the presence of salt in sand it is assumed that the object is to discover any tendency to absorb moisture, and, consequently, to cause damp walls. This could be equally well ascertained by drying some of the sand for some hours at a temperature of 212° F. Its weight should then be accurately taken and the sand exposed for some days to a moist atmosphere. Any increase of weight at the end of the period would be due to water absorbed from the air, probably owing to the presence of common salt.

ELECTRICAL NOTES.

The Chilean government telegraph lines now comprise about 7,500 miles.

The London Economist and Statist states that the firm of Siemens & Halske has obtained a contract for lighting the streets of the city of Mexico with gas and electricity.

The working by electric haulage of the Belgian vicinal or parish railways, between Charleroi and Montigny-le-Tilleul, Mont-sur-Marchienne, Lodelinsart, and Chatelet, all in the Charleroi colliery district, has been intrusted to the Société Electricité et Hydraulique.

Mr. Alexander Siemens, says The Engineer, who has had an opportunity of carefully comparing the relative initial costs of steam and electric power plants for driving their works, says that the capital expenditure in a new works is 30 per cent. less in the case of driving by electric motors. In the works of Messrs. Siemens eleven steam engines were replaced by seventy-two motors, representing a total of 1,400 horse power.

In a recent number of the Annales de Chimie et de Physique, M. Henri Moissan gives particulars of further researches accomplished by the aid of the electric furnace. He finds that with a current of 50 amperes at 50 volts, titanic acid is converted into crystallized oxide of titanium. With a current of 300 amperes at 70 volts a bronze yellow nitride of titanium is produced, having the composition Si_2N_3. When the current is increased to 1,200 amperes at 70 volts, this substance is decomposed and a carbide of titanium formed. Heating this latter with an excess of titanic acid, nearly pure titanium is obtained.

The electric plant at the railway station of Busigny, on the French northern line, supplies light for this station and for Cateau. There are continuous current dynamos, two alternators, and a 45 kilowatt transformer of Hutin and Le Blanc, which raises the tension from 115 to 5,000 volts. According to a communication which Sartiaux, the electrician-in-chief of that line, has addressed to La Nature, a strong detonation was suddenly heard in the generating station one evening last October. The attendant at once switched off the current. The low tension switches blew out, and smoke was seen to issue from the transformer case. A poor mouse was found to have short circuited the transformer, and an arc had formed, which lasted until the fuses gave way. The mouse had evidently been gnawing at the insulation, and had become carbonized as a reward. Only slight damage was done.

In a recent number of Cassier's Magazine Mr. E. G. Bernard, in an article on "Electric Ship Lighting," relates his experience in installing the second man-of-war lighting plant of the United States Navy—that on the Omaha. The circuit consisted of lead incased cabies, and Mr. Bernard writes that he has a vivid recollection of the difficulties met in boring several hundred ¾ in. and ½ in. holes for the port and starboard mains, through about 8 in. of gnarled oak almost as difficult to pierce as a tough metal. It is perhaps needless to say, he adds, that the cost of labor and tools for this part of the work formed no small item in the total cost of installation. Mr. Bernard states that lead incased conductors were finally discarded for ship work, except in special cases, for the reason that the protection which the lead covering was supposed to give from injury to the insulation, and from the entrance of moisture, was found to be illusory. Dents caused short circuiting on the sheaths of the conductors, and punctures, by permitting the entrance of moisture, led to bad grounds and to short circuits.

The rubbish in Budapest is collected in a special kind of closed cart, and is all brought to a depot just outside the town, says the Electrician. From here it is transported to a suburb, Szt. Lorintz, about a mile distant, along a normal gage railway. At Szt. Lorintz, the rubbish is carefully sorted by mechanical means, and the combustible part is burnt on step grates in ordinary boilers. At present the works are driven by a fifty horse power engine; but as the amount of fuel in the rubbish is sufficient, a hundred horse power engine is being erected. This will drive a 70 kilowatt 3,000 volt three-phase dynamo. An electric line, consisting of three wires of 4 mm. diameter, runs from the generator to the unloading depot above mentioned. Here there are two transformers, which reduce the pressure to 300 volts for the motors and 100 volts for lighting. The crane which transfers the boxes of rubbish from the carts to the trucks will be driven by three three-phase motors of 16, 8 and 3 horse power respectively. The craneway is 50 yards long, and the current is brought to it by means of two overhead wires and trolleys, the rails forming a third conductor.

A description of an absolute electrometer for measuring small electromotive forces of about one volt has appeared in the Comptes Rendus. The instrument, which has been designed by MM. Perot and Fabry, consists of an attracted disk electrometer, in which the necessary sensitiveness is obtained by greatly reducing the distance between the plates, says The Engineer. The attracting disk consists of the plane end of a glass cylinder about 6 cm. in diameter and 1 cm. high, this height being large compared with the distance between the two disks. The attracted disk consists of a thin circular disk of glass about 7 cm. in diameter, and which is virtually an infinite plane. These disks are lightly silvered, their parallelism is adjusted, and their distance measured by being traversed normally by a beam of monochromatic light, which forms interference bands between the light which has passed directly through the thin silver coating and that which has been reflected an even number of times at the silvered surfaces. The electrical attraction is measured by comparing the deformation produced by three springs, which carry the movable disk by the electrical forces, with that produced by a known weight when placed on the movable disk. The authors have obtained 0·0048467 as the mean value of the electromotive force of a Clark cell at 0° in electrostatic measure, and, taking the electromotive force in electromagnetic units as $1{\cdot}4535 \times 10^9$, the value of v, the ratio of the units obtained, is $v = 2{\cdot}9989 \times 10^{10}$. The authors think that in this determination, which they regard as simply a preliminary one, the mean error between the different measurements is 1 in 1,000.

MISCELLANEOUS NOTES.

The records of the United States Patent Office show that upward of 6,500 forms of car couplings have been patented in this country.

The French minister of war lately offered a prize for the swiftest bird in a flight from Perigueux to Paris—310 miles. There were 2,746 entries, and the winner did the distance in seven hours and thirty-four minutes.

The earliest discovery of iron within the present limit of this country was in the mountain range of western North Carolina, and the first effort to manufacture it into merchantable form was made in the State of Virginia in 1619. The foundry was destroyed by the Indians in 1622.

An absolute vacuum, or what is believed to be one, is said to have been recently produced by Prof. Elmer Gates, of Washington, by a novel method. Into a test tube made of a kind of glass which melts at a very high temperature, he poured a molten glass which melts at a much lower temperature, completely filling the tube, leaving no air space. After melting this inner glass, it was partially withdrawn from the tube by exhausting the air from the outer side and allowing it to flow down by gravity, but not so far but that the end of the tube was completely closed. It was then allowed to cool. As no air could enter the space left by the withdrawal of the glass, it is believed that a perfect vacuum was obtained.

The town of Enfield, Me., has probably the largest manufacturing plant in the world for the production of hardwood novelties, in almost endless variety and size. The concern takes the trees at the very stumps in the forest, setting them in motion, and never ceasing to push them forward by all the arts of ingenious manipulation, until they are distributed in innumerable shapes and sizes to purchasers far and near. Some idea of the productions here included may be obtained from the three months' record of 300,000 curry comb handles, and the six months' turn-out of more than 3,000,000 handles for hair curling tongs, besides nunberless rubber stamp handles, pail handles, tub handles, handles for shoemaking tools, drug boxes, pill and salve boxes of all sizes and shapes and colors, water proof and airtight mailing boxes, 300,000 wooden whip sockets, and more than 4,000,000 different sized and shaped lather and paint brush handles.

The process of preparing gold until it is reduced to a thickness of 1-280,000 of an inch is necessarily elaborate. The gold is first cast in ingots four inches in length and one inch in width, which weigh from ten to seventeen ounces, according to thickness. It is then passed between polished rollers, worked by steam, until it forms a ribbon twenty-eight yards long and 1-800 inch thick. These ribbons are then cut into 180 pieces, one inch square, and placed between vellum, and then the real business of the gold beater is begun. He beats for half an hour with a twenty pound hammer, making the inch square into three inches square; then these pieces are quartered, becoming 1½ inches square. He beats again for 1¼ hours, until the 1½ inch square becomes four inches square. The four inch pieces are again quartered and beaten and finally cut to proper size, viz., squares of 3⅜ inches, of a thickness (or rather "thinness") of 1-280,000 of an inch, and in this shape the leaf is lifted into books of paper.

It appears that wooden pavements find the most favor in Paris. The blocks are 8½ by 6¼ inches, these being laid on a Portland concrete foundation: a space of two inches is left between the curbstone and the side blocks, three rows of which nearest the curb are laid longitudinally with the curb, and this space is filled with sand, until the blocks have ceased expanding. The blocks are also grouted with Portland cement mortar; are also usually creosoted, though it is not assumed that this latter process really prolongs their life after they have been laid. On the completion of a pavement the common practice is resorted to of covering it with a thin layer of very fine gravel in order to harden the surface and make it less slippery. In Rome, on the other hand, pavements of stone blocks cut in a truncated pyramidal form are in favor, the tops of the stones being about five inches square and tapered down to 3½ inches square, the depth being some seven inches; these blocks are very carefully dressed, and the pyramidal shape enables the blocks to be easily removed in case of repairs.

The United States consul at Breslau has prepared an interesting report on the condition and methods of the book trade in Germany, which is published in the last issue of consular reports by the Department of State in Washington. The consul says even in this changing age the organization of the German book trade remains in principle what it has long been. The two main principles which make the trade as flourishing as it is are the fixed selling price and the right of the retailer to return unsold books. There is in Germany one bookseller for every 5,000 inhabitants. The German publisher spends little in advertising, for he sends out all his novelties on sale. The retailer circulates all his new books among likely buyers, and they become better known than through advertisements. The retailer pays for all the books bought during the year at the Easter fair of the following year. The discounts vary according to the class of book, from twenty-five per cent. on the selling price on scientific books to forty and even fifty per cent. on juvenile literature, besides which eleven copies are sent for ten, or thirteen for a dozen. The enormous number of scientific books published in Germany, including pamphlets, can only be explained by the existence of the intelligent retailers all over the country. The legal organization of the trade is the Verein, in Leipsic, consisting of 2,685 members. The maintenance of the selling price (5 per cent. being allowed for cash, periodicals excepted) is rigidly insisted on, and if the rule is broken, it is adjudged by the Verein that the publishers shall not supply the offender, or that they shall give him no credit or discount. Connected with this institution is a sort of publishers' and booksellers' clearing house in Leipsic, by which the ordering by retailers and the keeping of accounts between them and the publishers are facilitated and simplified, and the processes of ordering, packing, dispatching, and paying are greatly cheapened.

SELECTED FORMULÆ.

Solution for Stopping Falling of the Hair.—The Revue de Therapeutique gives the following:

Hydrochlorate of quinine	1	drachm
Tannic acid	2	"
Alcohol, 70 per cent	1½	pints
Tincture of cantharides	2½	drachms
Pure glycerine	1½	ounces
Cologne water	10	drachms
Vanillin	2	grammes
Pulverized sandal wood	1	drachm

This mixture, after being well mixed and shaken, is allowed to stand for four days, and is then filtered. It is rubbed into the scalp daily for the purpose named.—Therapeutic Gazette.

Gelatine Paste.—For mounting photos., etc.:

(a) White gelatine	4	oz.
Soak one hour in Cold water	16	fl. oz.
(b) Glycerine	1	"
(c) Alcohol	5	"

Dissolve a on a water bath, i. e., glue pot, and add b. Mix thoroughly and let cool a little, then add c. Some operators add 3 fl. oz. of glycerine, especially if the paper is to be mounted on cloth; but for regular photographic cards 1 oz. of glycerine is sufficient. Any white or colorless gelatine may be used, but for extra nice work, Nelson's No. 1 gelatine will be found superior to all others. It may be obtained of any photographic supply house.—The Western Painter.

Cement for Punctured Bicycle Tires.—Dr. Allsnell recommends the following:

Gutta percha	4	parts.
Caoutchouc	5	"
Isinglass	3	"
Carbon disulphide	40	"

M. S. A.

The cement is dropped into the crevices after they have been properly cleaned. If the rent is very big, apply the cement in layers. Bind up the rubber tire tightly with thread, let dry overnight and remove the protruding cement with a sharp knife, which must previously have been dipped in water.—Canadian Druggist.

Sculptor's Putty (modeling compound).—Mix 200 parts dry clay or powdered soap stone with 100 parts of wheat flour; stir the mixture carefully into 300 parts of melted white wax, not too hot. If desired, the mass may be colored at pleasure. The so-called "modeling clay" may be made by kneading dry clay with glycerine instead of water. The mass must be worked thoroughly with the hands and moistened at intervals of two or three days. To prevent evaporation, it should be kept covered with a piece of rubber cloth.—Pharmaceutical Era.

Insecticide for Plant Lice.—An effective insecticide for various insect pests on greenhouse plants is composed of methylated spirit, 200; soft soap, 20; quassia wood, 6; salicylic acid, 2½ parts. Macerate for several days; dilute with sufficient water and apply to the infested parts by means of a brush. Allow to dry on; the following day wash off with plenty of water.—Rev. Med. Pharm.

Test for Soap in Lubricating Oils.—To detect soap in lubricating oils, the oil is dissolved in ether, and the solution is treated with a saturated solution of metaphosphoric acid in pure alcohol. If any soap is present, decomposition and precipitation will take place. The nature of the precipitate will reveal the nature of the soap. When treated with perchloride of platinum, the precipitate will dissolve the reagent if soda soap is present, with potash soap the precipitate turns yellow and becomes crystalline; if no change takes place, the soap is an aluminum or iron soap.—Uhland's Wochenschrift.

To Restore Coins.—To restore the effigy on coins, the following method is recommended by Prof. W. Roux. The coin is thoroughly cleaned, even when the effigy has disappeared completely, and is placed in a solution of a metallic salt, such as sulphate of copper, between two electrodes. A strong current will give the quickest results. On the side facing the anode the deposited metal will bring out the effigy, on the other side the oxide formed will adhere best to the portions of greatest density, and thus reveal the destroyed effigy. If it is desired to have a metallic deposit on each side of the coin, the latter is placed horizontally on a support consisting of nonmetallic points.—Prometheus.

Ink Eraser.—The following is considered a good liquid eraser for ink spots on paper:

A.

Citric acid	2 ounces.
Water	16 fl. ounces.
Saturated solution of borax in water	3 fl. ounces.

Dissolve the acid in the water and add the borax solution.

B.

Chlorinated lime	6 ounces.
Water	16 fl. ounces.
Saturated solution of borax in water	3 fl. ounces.

Mix the lime and water, shake well, set aside for one week in a well stoppered bottle, decant the clear liquid and add the borax solution.

This composition is used by saturating the ink spot with solution A, removing excess of liquid with a blotter, and then appiying solution B. When the stain has disappeared, apply the blotter, and wash the spot, by the alternate use of clear water and blotting paper.

To Keep Ice.—The use of ice in small quantities, frequently repeated, is very general in many diseases, but it is found difficult to keep it from melting, especially when in small blocks. To obtain this result, the ice should be put in a vessel covered with a plate, which vessel should be placed on a feather bed, and covered with a feather pillow or cushion; feathers being very bad conductors of heat. By this plan a few pounds of ice can be kept several days, even in summer heat.—Popular Science News.

SELECTED LIST OF BOOKS
ON
MINING AND METALLURGY.

Cast Iron. Metallurgy of Cast Iron. A complete Exposition of the Processes involved in its Treatment, Chemically and Physically, from the Blast Furnace through the Foundry to the Testing Machine. By Thomas D. West. Fully illustrated. First edition. 12mo, cloth. 573 pages. Cleveland, 1897.....$3 00

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